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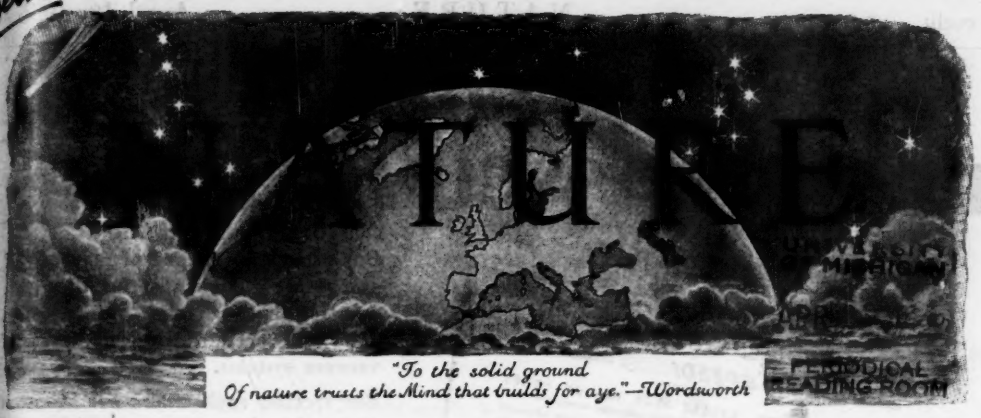

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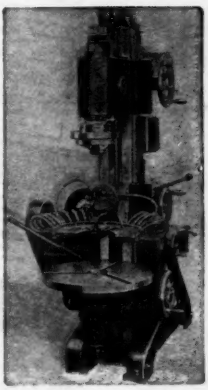

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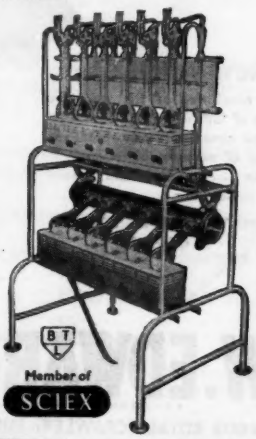

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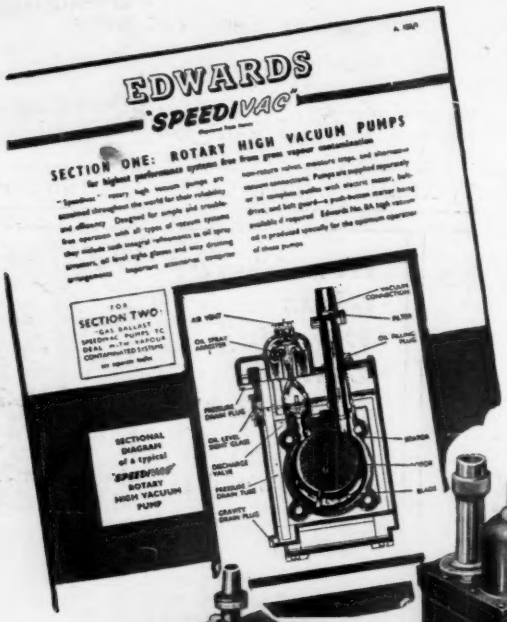
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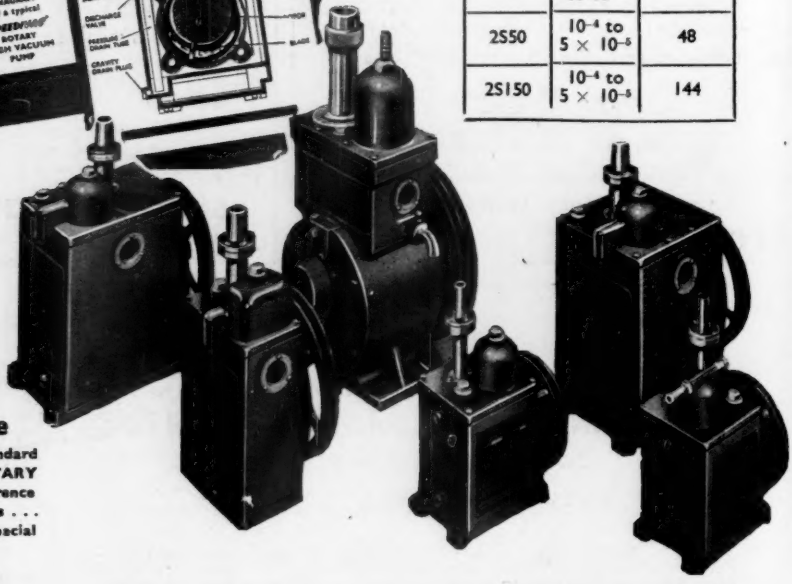

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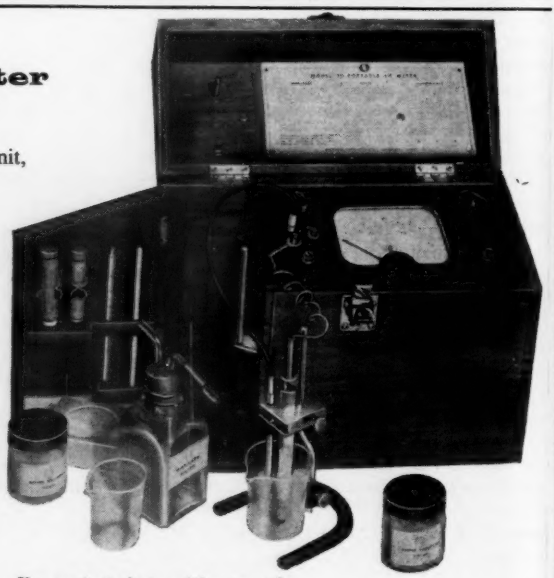

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SCIENCE AND DEFENCE

ALREADY in the Statement on Defence last year the Government expressed its concern at the mounting cost of unconventional weapons of war as the process of development continues, at the tactical and strategic problems presented by these new weapons, and at the necessity of holding a careful balance between the demands of defence and those of other sectors of the economy. Such considerations have lost none of their force in the meantime, and although the gross total expenditure on defence of £1,813 million and of £837 million on production and research are relatively unchanged from last year's figures of £1,864 million and £867 million, respectively, it is clear from the recent Statement on Defence, 1955* that science occupies a key position in the defence policy of Britain. Finance apart, that follows from the Government's acceptance of deterrence as the keystone of its new defence policy. The hesitations of last year have been cast aside, and the argument of the White Paper and the new order of priorities which it lays down start from the acceptance of the hydrogen bomb.

Overshadowing all else in 1954, the reasoning runs, has been the emergence of the thermonuclear bomb. The defence policy of Britain remains that of preparing against the risk of a world war, and so to endeavour to prevent it; the ultimate aim is the abolition of the use, possession and manufacture, not only of all nuclear weapons, but also of other weapons of mass destruction, together with simultaneous major reductions of conventional armaments and armed forces to agreed levels which would redress the present Communist superiority. Until, however, the Soviet Union agrees to participate in such a secure system of disarmament, the free nations must base their plans and preparations on the assumption that, if a major war were precipitated by an attack upon them, they would have to use all the weapons at their disposal in their defence.

Defence policy thus involves playing our full part in the defence of the interests of the free world as a whole, and particularly of the Commonwealth and Empire, in the 'cold war', as well as meeting the many other peace-time commitments overseas which arise from the position of Britain as a great Power with world-wide responsibilities. It is on the preparations against the risk of a world war that the existence of thermonuclear weapons has its main effect, and the outstanding feature of the White Paper is the way in which it analyses the implications of the assumption that the thermonuclear bomb is the primary deterrent against aggression. The power of the thermonuclear weapons exploded at Eniwetok and in the Marshall Islands is so much greater than that of the atomic bombs used in 1945 that accuracy of aim is less important. Attacks can be delivered by aircraft flying at great speed and at great heights, and while this alone greatly increases the difficulty of defence, there are no technical or scientific limitations on the production of nuclear weapons of still more devastating power.

The United States Government has announced that it is proceeding with full-scale production of thermonuclear weapons, and the Soviet Government is clearly following the same policy. The British Government announces frankly that, having fully considered all the implications of this step, it has decided to proceed with the development and production of such weapons; and it is clear that the decisive factor has been the plain fact that the use of nuclear weapons is the only means of countering the massive preponderance in conventional land forces of the Soviet Union and its Eastern European satellites.

The reluctance with which the Government has reached this decision is not concealed in the White Paper, and it was obviously shared by the Opposition and the Government side alike in the defence debate. Nevertheless, while recoiling from the prospect of using nuclear weapons, the necessity was accepted by all but a small minority as the only alternative to militant Communism, with the oppression and national and individual humiliation that this would bring. To show weakness or hesitation to use all means of defence at our disposal would only increase the risk; and while the Statement depicts deliberately and sombrely the consequences which would follow if such weapons were used in war, realization by both sides of the grimness of the struggle which would result and the certainty that all pretensions to world domination would at once be destroyed, does paradoxically offer new hope. If the free world stands together, determined, if necessary, to defend itself with all its resources, the nuclear weapon may well increase the chances of world peace far more than the chances of world war. This may be true even when the present predominance of the West both in stocks of weapons and in the means of delivering them have been reduced. As the Prime Minister emphasized, in opening the debate on the White Paper on March 1, we may well have reached a stage "where safety will be the sturdy child of terror, and survival the twin brother of annihilation".

The recurrent theme of Sir Winston's speech was deterrence. Unless a trustworthy and universal agreement upon disarmament, conventional and nuclear alike, can be reached and an effective system of inspection established, he said, the only sane policy for the free world in the next few years is that of defence through deterrents. For that purpose, Britain must possess the most up-to-date nuclear weapons and the means of delivering them. That position appears to have been generally accepted in the debate. Confusion of thought arose, first, over the conditions under which thermonuclear weapons should be used and, second, over the need for maintaining conventional forces. As Sir Winston pointed out, the development of nuclear weapons will affect the shape and organization of the Armed Forces, as well as of civil defence, and the statements accompanying the Army and the Navy Estimates as well

* Statement on Defence, 1955. Pp. 30. (Cmd. 9391.) (London: H.M. Stationery Office, 1955.) 1s. net.

as the Statement on Defence show that this is thoroughly realized, although the final shape is not yet clear. We cannot, however, sweep away our conventional weapons and forces: apart from our commitments to the North Atlantic Treaty Organization and the defence of Western Europe, substantial strength in such forces is still vital to enable Britain to fulfil its world-wide obligations.

Nevertheless, acceptance of the principle of deterrence or even of the order of priorities which it involves does not preclude criticism of the details of the Government's policy and programme as set out in the Statement. Indeed, the programme does not invariably conform to the order of priorities which it lays down, and there are sections, particularly those dealing with research and man-power, which are disturbing, and which suggest that the Government has not yet fully thought out the implications. Nor does the Statement afford any evidence that, for all the emphasis placed on research and development, the Government appreciates the extent to which successful defence is based on science, which in turn is dependent on preservation of the conditions which promote creative scientific activity.

The Statement on Defence could well be read in the context of the address on "Science and National Security" which Dr. L. A. Du Bridge delivered last October at the Johns Hopkins University and which has recently been published in *Science* (**120**, 1081–5; 1954). Dr. Du Bridge discussed frankly the ways in which science and technology promote national security. Without attempting to trace all the roots of national strength deep in the national way of life and the industrial, social, educational and economic systems, he began with the now generally accepted view that both military and industrial technology are rooted in fundamental science. From this it follows that fundamental science should be fostered by the government for four practical reasons: the dependence of progress on new knowledge; workers in fundamental science, being among the ablest and most imaginative in the country, provide an invaluable reserve immediately available at need to accelerate the development of military technology; the dependence of a continuing supply of scientists and technologists upon fundamental science in the universities; and the contribution of fundamental science to industrial technology, both in respect of new knowledge and of inspiring the workers in applied science.

Dr. Du Bridge's review of the steps taken in the United States in recent years to strengthen the position of fundamental research need not be considered here, apart from his reminder that it is still necessary to convince both industry and governments of the value—even from the point of view of defence alone—of encouraging fundamental research. His observations on the conduct in the United States of research for military purposes by the Department of Defense and the Atomic Energy Commission, and the differences between such applied research and fundamental research, however, bear closely on the immediate problem in Britain of the organization of science for defence. For one thing, Dr. Du Bridge regards variety of pattern in carrying out such applied research as having advantages. Diversity of approach and individuality are conducive to new ideas: but there is also a danger of scattering resources and so making them ineffective, of confusing policies and neglecting priorities.

Accordingly, with diversity of pattern, it is imperative that there should be one office to give guidance and co-ordination to all the Service agencies. In Britain this is the essential task of the Defence Research Policy Advisory Committee, and one of the disturbing features of the Statement on Defence is the absence of positive evidence that that Committee is discharging its task effectively. Moreover, defence research and the scientific and technical resources required for defence policy also need co-ordination with the requirements of civil research in industry, government departments, and nationalized organizations and the universities. There is little indication that such co-ordination exists; though the Joint Intelligence Bureau recently formed (see *Nature*, March 26, p. 529) and the creation of a post of Scientific Adviser to the Minister of Defence are steps in that direction.

Before considering that position more closely, Dr. Du Bridge's observations on the promotion of research in general deserve to be noted. Whether in fundamental or in applied researches, success is the outcome of good ideas, and ideas cannot be manufactured on a production line. We do not understand how they arise; but we know a good deal about the conditions which encourage the birth of ideas. Dr. Du Bridge details some of those conditions or rules, and points out that what is required is to see that they are applied flexibly and with imagination and understanding in each organization, and appropriately for the purpose to be served. Nor does it follow that the conditions under which they are successfully applied for one purpose in one organization will be appropriate and successful for another, even in the same organization. What is required is something more than the provision of adequate facilities, resources and even information: it is the environment or the atmosphere and the administrative apparatus that are all-important. These can stimulate creative thought and imagination, or they can repress by engendering frustration and interruption. The danger is that the effect of factors outside the control of the research organization will be overlooked; otherwise it would not have fallen to the individual scientist and his professional associations to make the main protests against the secrecy regulations and restrictions on the exchange of information or the movement of scientists beyond the minimum that can be demonstrated as essential for security.

Beyond this, Dr. Du Bridge makes an important point when he argues that the process of bringing together scientific and military experience in the development and use of new weapons should be continuous, and that the responsibility lies equally on the scientist and on the Services. The scientist working in a laboratory devoted to military purposes should keep himself continuously informed of the broad military problems as well as of the specific ones in his own field, just as the Service officer should be

thinking about technological possibilities. They should be continually exchanging ideas about problems. The first object of a scientific policy of defence should be to promote as effectively as possible the broad, intimate and vigorous discussion between scientists and Service officers on the problems of defence.

BIOLOGY AND RADIATION

Radiation Biology

Edited by Alexander Hollaender. Vol. 1: High Energy Radiation. Part 1: Chapters 1 to 8. Pp. ix+626. Part 2: Chapters 9 to 19. Pp. 627–1265. (Prepared under the Auspices of the Committee on Radiation Biology, Division of Biology and Agriculture, National Research Council, National Academy of Sciences, Washington, D.C.) (London: McGraw-Hill Publishing Company, 1954.) 140*s*. the two parts.

Medicina Nucleare

Introduzione alle Applicazioni Medico-Biologiche della Fisica Nucleare. Di Aldo Perussia, e coll. Pp. xii+878. (Roma: Il Pensiero Scientifico Editore.) 7000 lire.

Biological Effects of External X and Gamma Radiation

Edited by Prof. Raymond E. Zirkle. Part 1. (National Nuclear Energy Series: Manhattan Project Technical Section. Division 4—Plutonium Project Record: Vol. 22B.) Pp. xxvi+530. (London: McGraw-Hill Publishing Company, Ltd., 1954.) 58*s*.

RADIATION biology is an artificial creation of man: Can it rank as one of the natural sciences? A reviewer of "Radiation Biology", edited by A. Hollaender, may well wonder whether it is indeed a subject in the academic sense any more than, for example, arsenic biology would be. The importance to mankind of the biological effects of radiation is clearly increasing, and in fact has provided the stimulus and support for most of the newer work summarized here. But radiation, apart from its toxicological importance, may be a useful investigating tool (pre-eminently perhaps in genetics), and also sometimes a useful technological accessory, as in the development from irradiated *Penicillium* of strains giving a higher yield of penicillin. These diverse aspects do not really make up a logical whole. A symptom of a common confusion of thought is the statement that the use of radioisotopes as a research tool is omitted because adequate texts are already available; a more valid reason is logical incompatibility.

In these volumes, about one-quarter is devoted to effects of radiation on the mammal, two-fifths to various aspects of chromosomal damage, one-fifth to the physical principles underlying the interaction of radiation and matter, and one-twentieth to biochemical effects. In general, the many authors have provided a fair historical perspective within which to set more recent advances, and their treatment, if not exhaustive, is comprehensive. The earlier chapters on the interaction of radiation and matter are more didactic in manner than those written by biologists; but the primary effects of radiation are reasonably well understood, whereas as yet there are few general principles which might unify the great variety of biological observations. The way in which the primary effects of radiation are converted into chemical and hence biologically observable changes is almost unknown. These volumes should serve well their declared purpose of providing a standard book of reference.

"Medicina Nucleare", edited by Aldo Perussia, is an introduction to the biological and medical applications of nuclear physics. It is divided into four main parts dealing respectively with theoretical bases and general techniques; instrumentation, techniques and methods of detection and measurement of radiations; radioactive isotopes in biological research and clinical investigation; and applications of nuclear physics to radiotherapy. Of the twenty-one chapters, fifteen are by A. Perussia; the remaining six are by C. Salvetti (elements of nuclear physics), E. Gatti (the artificial production of radiations), M. Silvestri (nuclear reactors and the production of radioisotopes), L. Malatesta (radiochemistry), E. Gatti and A. Perussia (the principal means of instrumentation), and U. Facchini and A. Perussia (techniques and methods of measurement). There are appendixes on the biological risks of ionizing radiations and isotopic data, and a bibliography of books and journals. The book deals adequately with the present status of a large and rapidly expanding branch of biological science: it will probably become the standard Italian-language text-book in its subject.

"Biological Effects of External X and Gamma Radiation", edited by R. E. Zirkle, is in rather a different category. As the editor points out, the work reported was carried out between 1942 and 1945 as war-time research; it was written hastily and not afterwards edited carefully for a variety of good reasons. It is therefore not meant to be a polished and complete work in any respect. To radiobiologists much of the work described is now past history. The individual papers are the records of investigations carried out at the National Cancer Institute by the late Egon Lorenz and his group, and at Chicago by L. O. Jacobson, E. S. Guzmann Barron and their colleagues. These were at first considered as classified information; later they were made available with limited circulation, and parts were published in scientific journals. The novelty of many of the papers has thus faded; but some contributions have been brought up to date. Even if their current interest is limited, nevertheless it is valuable to have these reports now in a bound collected form ready for the library shelf in any part of the world.

R. H. Mole
T. C. Carter
J. F. Loutit

PROGRESS IN PHYSICS

Reports on Progress in Physics

Edited by A. C. Stickland. Vol. 17 (1954). Pp. iv+280. (London: Physical Society, 1954.) 50*s*.

VOL. 17 of the "Reports on Progress in Physics" is on similar lines to its immediate predecessors. It contains eight rather specialized articles of varying length, each dealing with recent advances in a particular branch or field of physics, the emphasis this time being on theoretical aspects. A useful innovation now introduced is that, in addition to the bound volume, paper-covered copies of the individual articles can be purchased separately at appropriate rates.

The longest article, some sixty-six pages, in the volume is contributed by C. J. Bouwkamp, who gives a masterly treatment and critical review of recent progress in classical diffraction theory. The main emphasis is on planar diffraction from the point of view of wave equation plus boundary conditions. The diffraction of guided waves is included, and both scalar and electromagnetic problems are discussed. Various modifications of the Kirchhoff and Kottler theories are dealt with, and the usefulness of variational techniques for the solution of a great number of diffraction problems is emphasized. In particular, the recent rigorous formulation of Babinet's principle in electromagnetic diffraction is described, and a brief impression is given of recent work on other problems in diffraction theory not dealt with in detail elsewhere in the article. The report concludes with a list of references to more than five hundred papers published since 1940.

Three reports deal with various aspects of nuclear and atomic physics: M. H. L. Pryce discusses nuclear shell structure; E. Teller the theory of the origin of cosmic rays; and W. Moffitt atomic valence states and chemical binding. Considerable evidence has been accumulated, particularly during the past six years, of the marked regularity of nuclear properties. The breaks at 2, 8, 20, 28, 50, 82 and 126 protons and neutrons and the arrangement of the so-called magic numbers at which closed shells occur into the two sequences A and B represented by $n(n + 1)$ $(n + 2)/3$ and $n(n^2 + 5)/3$ respectively, illustrate this quite clearly. Prof. Pryce summarizes the experimental and theoretical data in support of this arrangement and discusses the various models of nuclear shell structure, including the individual-level model with its limitations and success and the collective model of A. Bohr, which have been advanced recently to explain the regularity. He points out, however, that our knowledge of the origin of nuclear forces is still too slight to obtain a complete picture.

In his all-too-brief report of nineteen pages, Prof. Teller describes in a most fascinating way what primary cosmic rays consist of, how a relatively soft and minor component of the cosmic radiation originates from the sun, and that the random acceleration process, proposed by Fermi, and a physical location of the accelerating fields in radio stars, as suggested by Unsöld, together account satisfactorily for the main features of cosmic radiation. His discussion of the lasting effects that a great burst of cosmic ray intensity, which may have occurred in the far distant past, may have produced on our existing civilization is particularly interesting. W. Moffitt, in presenting a very general theory of the electronic structure of molecules, pays especial attention to the electron-pairing theory of chemical binding due to Slater and Pauling, and Van Vleck's valence-state concept is illustrated with respect to certain simple molecules. Orbital hydridization and the heteropolar character of certain bonds involving the establishment of an electronegative scale are also discussed.

The subject-matter of A. B. Lidiard's important article on antiferromagnetism is divided into two parts. The first deals with the paramagnetic transition metals of the iron series, and the second with a number of compounds of the transition metals (including the ferromagnetics, iron, cobalt and nickel) with elements of groups V, VI and VII of the Periodic Table. Recent experimental studies, particularly by the use of neutron diffraction, are surveyed, and on the theoretical side Van Vleck's approximate theory and its improvements, both by extending the model and by using more accurate statistics, are considered. A discussion of the super-exchange mechanism is included. The article concludes with a comprehensive and extremely useful table listing experimental papers on antiferromagnetism arranged by compound and by the property studied.

The remaining three articles deal with atmospheric phenomena. "Atmospheric Electricity" by J. A. Chalmers, an acknowledged authority on the subject, is largely a supplement to his recent book and suffers from too much sectionalization. A number of current problems are discussed briefly in turn. "Horizontal Movements in the Ionosphere", by B. H. Briggs and M. Spencer, is a survey of existing knowledge as obtained by radio methods. The authors, working in Cambridge, have themselves used the method of reflected radio waves observed at closely spaced points, and this method and results obtained by it are given most prominence, though other methods are dealt with more briefly. A discussion of the important but difficult question as to whether the movements in the ionosphere detected by the various radio techniques are true movements of the air or merely movements of the ionization is not attempted; but the various results obtained in Cambridge and elsewhere are carefully compared and contrasted.

Finally, the experimental observations from which the physical conditions of the solar corona may be derived are briefly reviewed by C. W. Allen, of the University of London Observatory. It is stated that during the past ten years so much has been learned about the corona that it is now a most useful astrophysical body for the accurate study of the activities of atoms at high temperatures. However, the irregularity and variability of the corona is still somewhat of a limiting factor. The picture of the corona which has been produced is one in which the physical effects are associated with the high temperature. The dynamical effects are also profoundly influenced by this temperature; but it is not high enough to account for all the ejection of coronal material as evidenced by the streamers and geomagnetic storms. Additional outward forces are required, the origin of which is not at present understood.

S. Weintroub

A CITY NATURALIST'S MUSINGS

A Naturalist's Life of New York

By Dr. William Beebe. Pp. x+165. (London: The Bodley Head, 1954.) 12*s.* 6*d.* net.

THE title of this book is somewhat misleading. It is not a natural history of New York in the strict sense, but a series of most enjoyable short essays woven around the prehistoric and modern geology and wild life of the district around New York. While, of course, Dr. Beebe's name is a guarantee that the scientific accuracy of the facts is impeccable, the somewhat light-hearted approach of the chapter-headings—"Too Old to be Seen", "Too Small to be Seen", "Too Disguised to be Seen", and so forth—is somewhat deterring to a British reader, accustomed to a more serious approach to what has become in some circles almost a semi-sacred subject. Americans often express surprise at the large number

of popular natural history books that appear in Britain, and it is evident from the present volume that in the United States even so eminent a naturalist as Dr. Beebe has to dress his material up to a degree that is fortunately unnecessary over here.

One series of essays is based on the palæontology of the New York region, and discusses creatures like the sabre-toothed tiger, mammoth, walrus and ground sloth. It is interesting to be reminded that the great-clawed ground sloth, remains of which were found in a cave eighty miles from New York, was given its generic name, *Megalonyx*, in a paper written in 1797 by Thomas Jefferson, later the third President of the United States. The next series of essays gives the historical view of wild life from the period when written records became available at the beginning of the seventeenth century. Manhattan is said to have been named by the Delaware Indians from the general intoxication that occurred when, according to the Indian legend, the first white men arrived and introduced the natives to the contemporary equivalent of a cocktail. In 1770, we learn, the inhabitants of Westchester County had to discover, in the hard way, that a bounty is an inefficient method of controlling wild animals. The 20*s*. for a wolf offered in an ordinance in that year had six years later to be increased to £3. Even to-day it is doubtful if many 'practical men' have grasped the fact that animal populations are remarkably resilient, and that what passes for 'control' is usually merely a slight depression of numbers that it is well within the capacity of the population to replenish. There is often no half-way house between the wasted effort of a regular thinning and near-extermination.

Among the essays on contemporary wild life in and around New York, those that deal with birds are the most likely to interest readers in Britain. We learn that fifty years ago sixty species of bird nested in Central Park, and that some two hundred have been recorded there at one time or another. To-day only half a dozen breeding species remain, and Dr. Beebe attributes the decrease to atmospheric pollution by automobiles, which is accentuated by the steady closing in of lofty buildings. In a fascinating essay, Dr. Beebe describes how in 1904 he anticipated our modern passion for migration-watching by spending a night in the torch of the Statue of Liberty, which sways two feet in the wind.

The book is illustrated with delightful little humorous sketches by Donald T. Carlisle.

R. S. R. Fitter

HOME-LIFE OF THE ATLANTIC SEAL

The Seals and the Curragh

Introducing the Natural History of the Grey Seal of the North Atlantic. By R. M. Lockley. Pp. vii + 149 + 8 plates. (London: J. M. Dent and Sons, Ltd., 1954.) 15*s*. net.

IN this book R. M. Lockley gives us a remarkable insight into the home-life of the grey or Atlantic seal. F. Fraser Darling has already studied and written of this animal at some of its Scottish haunts; but the book under review is a more intimate study, for the author literally lived with the seals during the breeding season, and largely won their confidence. He wisely does not give the site of his seal nursery; but we are told that it is somewhere on the coast of Wales, where, incidentally, great mortality to the young seals must have resulted from the hurricanes of November 1954.

The author sailed by himself to the remote beach where the seals have their young, and having drawn up his curragh (which he tells us was a gift from Eire) above high-tide mark, slept beneath it for a month, studying the seals, which almost accepted him as one of themselves. Many of the things he saw had never been seen by man before, and he has recorded his observations in the masterly prose which those who have read his earlier books have come to expect of him. He watched the birth of the seal calves, and weighed them daily. One of them (p. 51) increased in weight for the first ten days at an average rate of 3 lb. during each twenty-four hours. At its Scottish nursery islands, the Atlantic seal is a land animal for at least a fortnight after birth; but the author (p. 53) records that he watched a seal calf called to the sea by its mother for a swimming lesson (returning to the beach later) on the third day of its life. The gestation period of the Atlantic seal is almost twelve months, and when this calf was fourteen days old its mother mated with a bull (p. 58). The author (p. 84) saw the seals mating under water, the animals being entirely submerged.

The author describes the little-known 'spring dances' of the seals and has watched what would appear to be a habitual second mating at this time.

The book is illustrated by excellent photographs, and a map of the distribution and breeding places of this seal in Britain. His map gives the Island of Mull area as a larger breeding ground than the Outer Hebridean breeding area—Shillay, Gasker and Hasker—but on these three latter islands probably three times as many Atlantic seals are born as in the Isle of Mull area.

The publishers are to be congratulated on the format of the book, on the excellence of the paper, the printing, and the binding. Seton Gordon

CRYSTALLOGRAPHIC STRUCTURE REPORTS

Structure Reports for 1945–46

Vol. 10. Pp. viii + 325. 45 florins; 12 dollars; 84*s*.

Structure Reports for 1950

Vol. 13. Pp. viii + 643. 80 Dutch florins; 21.50 dollars; 151*s*.

Edited by A. J. C. Wilson. (Utrecht: N.V.A. Oosthoek's Uitgevers Mij, 1953–54. Published for the International Union of Crystallography.)

THE successive appearance of Vol. 10 (1945–46) and Vol. 13 (1950) of "Structure Reports" is in accordance with the plan of starting after the War with Vol. 11 (1947–48) and working in both directions, so as to keep the series relatively up to date while making up the back-log as soon as possible. The abstracts maintain the high standard of accuracy and thoroughness characteristic of former volumes, and a feature which is particularly welcome to English-speaking readers is, as would be expected from an International Union, the excellent coverage of foreign journals, including those published in Russian. This must, however, add considerably to the work involved, and a recent advertisement for a full-time assistant editor directs attention to the heavy expense of adequate abstracting. Indeed, the

price already makes it almost impossible for individual research workers, to whom they are well-nigh indispensable, to buy these abstracts.

The work involved might well be less if published papers always contained the data given in "Structure Reports". In the judgment of the editorial board, this particular range of information is thought to be sufficiently important to be inserted even if the abstractors must calculate some of it themselves in order to include it. In these circumstances the International Union of Crystallography might perhaps require all appropriate papers submitted to its own journal, *Acta Crystallographica*, to contain this information in the desired form, and possibly make general recommendations about the publication of papers on structural crystallography.

The amount of work sometimes undertaken by abstractors is indicated by the report on AsCuZn, where the abstractor's comment almost constitutes an original publication on the subject, while the collection of data on a particular topic, such as manganese oxides, is nearly as valuable as a review article; and since these later volumes contain cross-references to earlier ones, and occasionally, as for β-uranium, relevant comments from papers published as recently as 1954, the series does constitute an extremely valuable work of reference.

A general comparison of the two volumes illustrates the rapid development of crystallography since the end of the Second World War. Topics almost if not completely absent from Vol. 10 which have appeared or expanded by 1950 include crystal structure determination by means of electron and neutron diffraction, bond-length and bond-angle determinations by microwave methods, the preparation and elucidation of clathrate compounds of the rare gases, the use of statistical methods in the interpretation of X-ray diffraction data, and the determination of the absolute configuration of an optically active compound.

Mention of the use of etch figures in space-group determination comes as a welcome reminder of the many older physical and morphological techniques which crystallographers of the new generation, conscious of the importance of X-rays, often and perhaps unwisely neglect. On the other hand, crystallographic data for a number of proteins remind us that X-ray diffraction methods have already made a contribution to biochemistry, and now seem competent—at least in principle—to solve structural problems complex beyond all but the wildest dreams of even twenty years ago.

H. J. Grenville-Wells

ELECTRONICS IN THE PHYSIOLOGICAL LABORATORY

An Introduction to Electronics for Physiological Workers

By Dr. I. C. Whitfield. Pp. ix+236. (London: Macmillan and Co., Ltd.; New York: St. Martin's Press, Inc., 1953.) 18*s*. net.

THE rapid advances in electronic techniques during the Second World War have influenced research in physiology, so that most laboratories now have a quantity of electronic equipment. Many new research students in biology have to grapple with this equipment, about which they have no knowledge. This has inevitably induced the appearance of a number of books intended to make biologists familiar with the new techniques. Some have been merely collections of circuits; those which have attempted to teach electronics have generally begun simply but have quickly become technical in idiom and mathematical, so that the biologist loses contact and flounders on despairingly. This is another book introducing the biologist to electronics, but one in which the author manages throughout to keep at a steady level of treatment comprehensible to its intended reader. It is emphasized that this book is not intended for 'idle hour' reading; and although at the end the reader will not be able to design circuits, he should be able to understand the operation of equipment commonly used in electrophysiology.

The first chapters introduce the simple concepts of direct and alternating current supplies. Apart from a tendency to use alternative terms indiscriminately (for example, voltage and potential), the style is clear. Analogies to commonplace events can be misleading and a considerable number are included; but the consistently skilful treatment makes them informative and attractive. It is surprising that so much ground can be covered in two chapters and still provide an intelligent concept of such topics as load matching, time constant and resonance. The author continues with a brief consideration of thermionic emission, followed by careful descriptions of multi-electrode valves. Particular attention is given to their dynamic characteristics and to equivalent circuits for triodes; but the pentode is dismissed very briefly. A sketchy introduction to simple multi-stage amplifiers precedes a digression to gas-filled tubes and photocells. The various types of photocell are described and their limitations emphasized.

Power supplies and rectification are next considered, and the description of each type of rectifier circuit is very instructive. The practical problems of regulation and ripple attenuation are illustrated numerically; and although the method for estimating smoothing is unusual, it gives a picture without mathematical complication. Stabilization of power supplies comes in a later chapter: the dynamic characteristics of neon stabilizers are described and considerable attention paid to hard-valve stabilization.

The most interesting chapters to the biologist are those concerned with feedback, noise and biological amplifiers. The introduction to feedback is not very helpful, but the 'cathode follower' is explained well; the arithmetic is simple but demonstrates the effects on input and output impedances and hence the circuit applications. Sources of, and reduction of, noise and interference troubles are of practical value to most readers; but there is a surprising absence of information about elimination of stimulus artefacts which are troublesome to many electrophysiologists.

The book finishes with a description of display methods—the types of cathode-ray tubes, their operation and typical distortions. Trigger circuits, oscillators and time-bases are given extensive treatment. Most of the circuits in general use are mentioned, and in particular the flip-flop and the Miller time-base are very clearly defined.

This book does not attempt to attain a high level of technicality. It is intended to be simple and must be thus estimated. Criticism can be made of the lack of detail and of over-simplified explanation and mathematics; but the book keeps to its aim, and in that simplicity has its value. B. C. Abbott

Isotopic Tracers

A Theoretical and Practical Manual for Biological Students and Research Workers. By G. E. Francis, W. Mulligan and Prof. A. Wormall. Pp. xvi+306. (London: University of London, The Athlone Press, 1954. Distributed by Constable and Co., Ltd.) 37*s.* 6*d.* net.

THE authors of this book have experience both of teaching and using isotopic tracer techniques; they write on both theoretical and practical aspects of the subject. They describe the preparation, properties and measurements of radioactive and stable tracers and their compounds. The sections on autoradiography, health hazards and syntheses are excellent, and sound practical details are given for a variety of experiments which are biased in favour of biological investigations. Experimental data are frequently given in the form of useful tables and graphs. References are often made to original literature and other texts.

The book might be criticized on a number of points. The implications of the statistical interpretation of disintegration-rates should have been discussed in the text and not mainly in the appendix. The use of sodium hydroxide for the purification of deuterium oxide seems unwise; furthermore, the use of chromic acid is suggested instead of chromium trioxide. Their first definition of specific activity in terms of the ratio of numbers of atoms is not in general use; and even in their own experimental section it does lead to an anomalous situation (experiment 2).

In spite of these criticisms, the book can be recommended to biologists who wish to survey, or use, tracer techniques: even for biological students, however, more information on results would be desirable. Other research workers and teachers will find the book useful as a concise summary of the subject.

S. J. THOMSON

Rome Beyond the Imperial Frontiers

By Sir Mortimer Wheeler. Pp. xii+192+38 plates. (London: G. Bell and Sons, Ltd., 1954.) 25*s.* net.

IN this valuable work Sir Mortimer Wheeler presents a critical discussion of the extent of the diffusion of Roman objects, made in Italy or within the Empire, and draws conclusions on the results of the penetration of Roman influences during the first three centuries of the Christian era. The evidence is dealt with under the headings of Free Germany, Africa, and India and the Far East in this order. In the case of Europe this evidence is both literary and archæological, and in presenting a masterly summary of this aspect Sir Mortimer draws largely on the recent extensive work of Eggers, of Broholm and others. His own conclusion is that Roman trade in Europe became important in the first century, when the spread was from Italy by way of the Danube to the Baltic and to Bohemia. About the end of the second century objects made in Gaul and the Rhineland were carried to the north-east and east. Later there was an extension from South Russia to Byzantium.

After a brief section on recent work in the Fezzan and the Hoggar in the Sahara, Sir Mortimer deals with the important discoveries in India, at Arikamedu, Taxila and Begram, with which he has been associated. His general conclusion is that the most important impact of the Western on the Eastern world occurred in the early centuries of the Christian era, when it produced a significant change in Buddhist art.

The plates in this book are most carefully chosen. The evidence is assembled with the author's usual skill. A minor suggestion is that the concluding "Retrospect" emphasizes five imports, and the general reader might well read this section first.

John William Bews

A Memoir. By George W. Gale. Pp. 140. (Pietermaritzburg: University of Natal Press, 1954.) n.p.

PROF. J. W. BEWS, who died in 1938 at the early age of fifty-three, was for many years a leading figure in botanical circles in South Africa and was one of the foremost plant ecologists of his day. A well-written account, delayed by the War and other causes, of his life and work has now appeared. The author, who is dean of the Faculty of Medicine in the University of Natal, was one of Bews's early postgraduate students in botany at Pietermaritzburg. It was General Smuts, with whom Bews was on friendly terms, and with whom he shared a common interest in the grasses and grasslands of southern Africa, who first suggested that there should be some permanent record of Bews's life and work.

The book gives a detailed and interesting account of Bews's life, including his boyhood in the Orkneys, for he was the son of an Orkney farmer, his student days at Edinburgh, where he graduated in both arts and science, and his working-life in South Africa. In addition to his ability as an ecologist and as a teacher, Bews later proved himself to be an able university administrator. He was, in fact, one of the founders of university education in Natal. Many of his students now hold important botanical posts in South Africa. The writer gives a descriptive account of Bews's published work, of which there were seven books, including works on human ecology.

Squirrels

By Monica Shorten. (New Naturalist Special Volume.) Pp. xii+212+15 plates. (London: William Collins, Sons and Co., Ltd., 1954.) 15*s.* net.

THIS admirable book combines the scientific approach with clear and attractive writing. It will be news to many of the author's readers that the supposed hibernation of the red squirrel is a myth. The animal cannot live for more than a few days without food, and has been watched in full activity in Switzerland when the thermometer stood at −15° C. The author, writing first about the red squirrel, tells us many interesting facts about it. The present race in Britain (like the capercaillie) has been introduced at various times, although the native stock may have survived in the counties of Sutherland and Inverness. Harvie Brown recorded a red squirrel on Beinn Bhrotain, a high hill in Mar 3,829 ft. above sea-level, at least nine miles from the nearest tree. This looks like migration between the Scots fir forests of Mar in Aberdeenshire and Glen Feshie in Inverness-shire. In her notes on the red squirrel's enemies (p. 36), the author does not mention the golden eagle, which preys on it in Scotland, in Switzerland, and in other lands.

The author tries to be fair to the grey squirrel, an unpopular immigrant from America, and she does not find it proved that its increase is the reason for the decrease of the red squirrel. The book is enriched by some excellent photographs and maps.

SETON GORDON

TWO GEOLOGICAL CENTENARIES

G. B. GREENOUGH, F.R.S. (1778–1855), and Sir HENRY DE LA BECHE, F.R.S. (1796–1855)

By V. A. EYLES and J. M. EYLES

IN April 1855 the geological world suffered the loss of two of its best-known figures, George Bellas Greenough and Henry Thomas de la Beche. One of them, Greenough, was a founder and first president of the Geological Society of London, doyen of the many geological societies established since; while to de la Beche we owe the establishment of the Geological Survey of Great Britain, a pioneer among such bodies.

At the opening of the nineteenth century, geology was a new science, completely unorganized, and in Britain the number of its devotees, nearly all amateurs, was comparatively small. Within the life-time of Greenough and de la Beche the position so changed that the science attained complete independence, with its own professional societies; and furthermore, its importance to the country obtained official recognition. This state of affairs was the result in no small measure of the efforts of these two men.

G. B. Greenough, originally George Bellas, had assumed the surname of Greenough while still a youth, on inheriting a considerable fortune from his maternal grandfather. He was educated at Eton and Pembroke College, Cambridge, and later studied law at Göttingen. Here, however, the lectures of the anthropologist, J. F. Blumenbach, seem to have implanted in him the taste for science, and for geology in particular, which largely determined the future course of his long life. From Göttingen he went to Freiberg to study under the eminent geologist, A. G. Werner, whose views he adopted and advocated for many years. After further travel he returned to Britain in 1801. Then for some years he took part in the activities of the newly formed Royal Institution, meeting Humphry Davy, with whom he visited Ireland in 1806. In 1807 Greenough was elected to Parliament as member for one of the pocket boroughs, that of Gatton, Surrey. Although he took his political duties seriously, after 1812 he seems not to have taken any further public part in politics.

While political activity was but a passing phase in his life, his interest in geology continued to grow. In 1807, a few months after being elected a Fellow of the Royal Society, Greenough joined with a dozen other enthusiasts to form what one of them called "a little talking Geological Dinner Club", becoming its treasurer and chairman (or president). This club was established by 1811 as a regular geological society, with Greenough as first president, and it began to issue *Transactions*. In 1825 the society was formally incorporated by Royal Charter as the Geological Society of London, which now has more than two thousand members.

The new Society had not escaped teething troubles, for during the first few years of its existence it met with serious opposition from the Royal Society, which, jealous of its own authority in the field of scientific inquiry, endeavoured to suppress the newcomer. It seems to have been due principally to the resistance of Greenough that the senior Society, in the person of its president, Sir Joseph Banks, and other prominent Fellows, was unsuccessful in its efforts.

Within a year or so of its formation, the new Geological Society set up a committee to encourage the production of geological maps, then very much a novelty. On November 6, 1812, Greenough presented to the Society "Nine Maps of England with the principal Strata sketched in", and as a result was specifically requested to construct a geological map of England upon a large scale. He set about the task methodically, combining the results of his own field-work with that of other geologists. The resulting work, on a scale of 11 miles to the inch, was published by the Geological Society in 1820. Though now almost forgotten, it was for its time a work of great merit, superior in accuracy to the great pioneer map of William Smith, published in 1815. It went into a second edition in 1840 and a third in 1865.

Greenough continued for the rest of his life to serve the Geological Society in one way or another, either as a member of council or as president, an office to which he was re-elected in 1818 and again in 1833. He made no contribution to the publications of the Society other than his presidential addresses, but frequently took part in the debates which followed the delivery of papers, generally adopting a somewhat conservative and critical attitude when new ideas were discussed. His contributions to the literature of geology were, in fact, remarkably few, in view of his long association with the science, though in 1819 he published a series of essays entitled "A Critical Examination of the First Principles of Geology". These are now of historical interest only; but they afford a well-documented record of views held and arguments used in the geological discussions of the period.

Greenough also spent many years in compiling a large geological map of India, the first of its kind, which he exhibited to members of the British Association at Liverpool, in 1854. Incidentally, it is worth recalling that he was present at the first meeting of the Association, at York in 1831.

Closely allied to Greenough's predilection for geology was his interest in geography; when the Geographical Society was founded in 1830, he served on its first council, and was elected president in 1839. The science of ethnology, too, claimed some of his interest and attention.

About 1822 Greenough commissioned a young architect, Decimus Burton (later one of his executors), to build him a house in Regent's Park, London. Known as Grove House, it was deemed sufficiently noteworthy at the time to be illustrated in contemporary publications. A coloured view of "The Seat of G. B. Greenough Esq." appeared in R. Ackermann's "Repository of the Arts etc." in 1828. The house still stands at the north end of Park Road, beyond Hanover Gate. In 1953 it was acquired by the Nuffield Foundation, who have, regrettably, renamed it Nuffield Lodge. Here Greenough entertained his friends and fellow scientists at dinner parties and soirées, during which scientific matters were the main topic of conversation. Here, too, he housed his extensive collection of books and maps, which on his death passed to the Geological and Geographical Societies. His collection of rocks and fossils went to University College, London, with the foundation of which he is said to have been closely connected. His name is still

commemorated there by the Greenough Club, in the Department of Geology.

Greenough is said to have been of pleasant but shy and modest disposition. He was a distinguished representative of a type seldom met with to-day—an amateur, in the true sense of the word, well versed in science, who had the means and inclination to make science his career. Although Greenough made no great contributions to scientific knowledge, it is quite clear that by his own labours, and by his encouragement of others, with financial assistance or otherwise, and by his long service on the councils and as president of scientific societies, he contributed much to the advancement of science as a whole. His singleness of purpose persisted to the end of his life. It is best illustrated by the fact that at the age of seventy-six, after taking the precaution of making his will, he set out for Italy and the East, bent on further geological and geographical researches. Illness prevented him travelling beyond Naples, where he died on April 2, 1855.

Henry Thomas de la Beche became a member of the Geological Society in 1817, when he was twenty-one, shortly before Greenough assumed his second presidency. His early years had been spent at Charmouth and Lyme Regis, in a district then becoming famous for its fossil remains, and this may have led to his early interest in geology. At all events, in 1819 he read a paper on the geology of the coast between Bridport and Babbacombe Bay to the Geological Society. In the same year he became a Fellow of the Royal Society. He travelled widely on the Continent as well as in England and Wales to increase his knowledge of geology. In 1824 he visited family estates in Jamaica and on his return described the geology of the island to the Geological Society.

De la Beche made numerous valuable contributions to geological literature; but, in retrospect, the most significant task he undertook was when about 1830 he began to colour geologically some of the new one inch to the mile maps of the Ordnance Trigonometrical Survey. The importance of this work was appreciated, and in 1832 he received a grant from the Treasury to enable him to continue it. In 1835 he was appointed on a salaried basis to continue his geological mapping, and this year is accepted as that of the foundation of the Geological Survey of Great Britain. The story of the early years of the Survey has been told more than once, and it is clear that De la Beche was particularly well fitted to be the first director of this new national scientific service. He was not only a distinguished geologist, but also proved himself an able administrator, possessing to a marked degree the qualities of tact, firmness and an understanding of the official mind so necessary to one in his position. Some years ago, Dr. F. J. North published extracts from De la Beche's correspondence and note-books[1], which gave clear evidence of this ability. Other letters of De la Beche (so far unpublished) are preserved among the correspondence of Sir Robert Peel now in the British Museum. From these letters it is evident that the Director of the new Geological Survey had no hesitation in by-passing the 'usual channels' and making a direct approach to higher authorities, when he deemed it necessary. In 1841 he wished to obtain sanction for an increase in his financial estimate for 1842–43, from £1,400 to £1,900. For this increase he had a good reason, namely, the addition to his staff of two new men, John Phillips, the palæontologist, and young Andrew Ramsay, later to become director himself. Nevertheless, it was not a good time to seek permission from the Treasury for an increase, however modest. The national finances were in an alarming state, with a falling revenue and a rapidly mounting deficit. In August 1841, a Tory government with Sir Robert Peel as premier had replaced Lord Melbourne's Whig government, and drastic measures were expected. The winter of 1841–42 proved to be one of the worst, economically and industrially, through which Britain has ever passed. Yet, on November 1, 1841, De la Beche wrote from Fishguard to Canon Buckland, then president of the Geological Society as well as professor of geology at Oxford, explaining his apprehension over his estimate, and suggesting that a direct approach to Sir Robert Peel would be of assistance. Buckland immediately forwarded this letter to the premier, with a covering note containing a warm recommendation of De la Beche, his work and his staff. On November 8, with remarkable promptitude and commendable brevity, Peel replied: "My dear Dr. Buckland, Pray assure Mr De La Beche that the Geological Estimate which he proposes for the ensuing year shall undergo no curtailment. Most truly yours, Robert Peel".

It is an interesting sidelight on the character of the great politician and financial minister to find that at such a time he showed no inclination to allow cheese-paring at the expense of a scientific service. It should be remembered, of course, that Peel had been a Fellow of the Royal Society since 1822, and had become a Fellow of the Geological Society in 1840, so that some sympathy towards science was not unexpected. However, only six months later, he was to introduce a Budget in which, faced with a deficit of more than two million pounds, he imposed an income tax of 7*d*. in the £—a most unpopular measure, for there had been no direct tax on income since the war ended in 1815. Gideon Mantell, another well-known geologist, recorded in his journal on May 18, 1843: "Went into the City and received my dividends at the bank: Peel's rascally tax being subtracted from my hard earnings".

The economic worth of the work then being carried out by the Geological Survey in the South Wales coalfield was undoubtedly appreciated; and the award of a knighthood to De la Beche in April 1842 no doubt indicated that Peel valued his services highly.

A few years later, in August 1844, De la Beche again asked Buckland to approach Sir Robert Peel. This time he pointed out the disadvantages of the Geological Survey's subordinate position under the Trigonometrical Survey, which had its headquarters in Southampton, and was itself in turn controlled by the Board of Ordnance. The Museum of Economic Geology, which Sir Henry also directed, was administered by the Department of Woods and Forests, and a transfer would bring the Survey and the Museum under one head, and the Survey itself into closer relation with mining and agriculture. This application also was successful, and the Treasury minute of December 27, 1844, effecting the transfer, was drawn up by Peel himself.

In 1848 Sir Henry de la Beche, then a member of the Council of the Royal Society, and also president of the Geological Society, was entrusted with the delicate task of discovering whether Peel (no longer holding political office) would stand for the presidency of the Royal Society, then becoming vacant by the resignation of Lord Northampton. An account of the meeting is recorded in a memorandum by Peel, who

wrote, *inter alia*: "I replied that I was prepared to give an immediate and decisive answer—that in my opinion the President of the Royal Society ought to be a distinguished man of science . . . that I would oppose any other nomination than that of a man of science". In the event, Lord Northampton was succeeded by William Parsons, third Earl of Rosse, and a distinguished amateur astronomer.

Peel died suddenly in 1850, and so did not witness the great events of 1851. In this year, on May 12, the new Museum of Practical Geology in Jermyn Street was opened by the Prince Consort; and in the following November the Government School of Mines and of Science applied to the Arts (now the Royal School of Mines and the Royal College of Science) was opened in the same building, with Sir Henry de la Beche as its first president.

This was the climax of De la Beche's career. In 1853 his health began to deteriorate, although he continued to attend regularly at his office. Early in 1855 he was awarded the Wollaston Medal by the Geological Society; but he was already confined to a wheel-chair by partial paralysis. He died on April 13 at the early age of fifty-nine, only two days after his last visit to the Museum. Sir John Flett, director of the Geological Survey during 1920–35, wrote of De la Beche in his centenary history of the Survey: "He had lived to see the fruition of his great designs, and to-day at South Kensington the Geological Survey and Museum and Royal School of Mines, housed in magnificent buildings, form a striking monument to his far-sighted policy and sound judgment. Nothing that he did has failed and with the progress of the years all his projected enterprises have expanded and developed".

[1] *Nature*, **143**, 254 (1939).

SIR JOHN BLAND-SUTTON, Bart. (1855–1936)

By W. R. BETT

A HUNDRED years ago, on April 21, 1855, at Enfield, Middlesex, was born John Bland Sutton, the eldest son of a market gardener, butcher and amateur medical practitioner, and later to become the most eminent pathologist-surgeon of his day and a great naturalist in the tradition of John Hunter, whom he worshipped. Like Hunter, he was brought up in the country, and like Hunter, he was proud of his humble origin and, indeed, also of his Cockney accent. At the age of ten he was taken to see Hunter's house in London, at Earl's Court, and the den in the garden where the menagerie of wild animals was kept; and ever after, this great surgeon-naturalist remained his kindred spirit. Having worked for two years as a school-teacher, Sutton decided to become a surgeon and, like his hero, approached surgery through anatomy and comparative anatomy. After a preliminary grounding at Thomas Cooke's private school of anatomy in Bloomsbury, he entered the Middlesex Hospital Medical School in 1878 at the age of twenty-three, and while still a student was appointed prosector of anatomy, and in the following year junior demonstrator. Having no money to spend on sport and social diversions, he worked all day and far into the night. He was a popular teacher, whose witty demonstrations came to be known as 'Sutton's entertainments'. In 1882 he qualified as a medical practitioner, and two years later obtained the fellowship of the Royal College of Surgeons. In 1886 he was elected assistant surgeon to the Hospital and lecturer on anatomy in the Medical School.

Sutton's long and intimate connexion with the London Zoological Gardens began with his appointment in 1881 as prosector, and for five years he performed the post-mortem examinations on all the animals dying in the Gardens. Many of his findings formed the basis of his first book, "Ligaments: their Nature and Morphology" (1887), which revolutionized anatomy by explaining some of its anomalies in the light of morphology. In "Evolution and Disease" (1890) he attempted to show that there is a natural history of disease, as well as of plants and animals. Keenly interested in the problem of rickets in young lions at the Zoo, he fed them a diet of cod-liver oil, bone dust and infant's food, but this was not "a pecuniary success".

Around 1889 a Dr. J. B. Sutton opened a shilling dispensary in the Euston Road. As this was rumoured to be Bland Sutton's venture and he was frequently called out in the night for "cheap midwifery", he assumed the name of Bland-Sutton by deed poll.

A new chapter in Bland-Sutton's life started in 1896 when he was elected surgeon to the Chelsea Hospital for Women, which he rapidly made the Mecca for pelvic surgeons from all over the world, for he created the gynæcological surgeon in place of the gynæcologist. When he first performed hysterectomies for fibroids he was called "a criminal mutilator of women"; but he was later hailed as a pioneer who disestablished the "couch-invalid", rendering her capable of earning her own living or becoming a companion to her husband. He made a fortune out of hysterectomies and for a time appeared to lose interest in general surgery. He was the first to remove a tubal mole, which he made a familiar condition to the gynæcologist, and his papers on the origin of ovarian cysts in animals, on ovarian dermoids and on menstruation in monkeys were classics in their day.

For many years regarded as the surgeon to the dental surgeons, Bland-Sutton was an honorary member of the Odontological Society, before which he read valuable papers on comparative dental pathology, and to him we owe the first scientific classification of odontomes. His book "Tumours, Innocent and Malignant" (1893, seventh edition 1922) was a 'best-seller' and won him world-wide fame. It was so copiously and so dramatically illustrated as to make the text seem almost superfluous; the author had no use for photographs, and rendered a great service to medicine and to literature by resuscitating the art of wood-engraving. A fluent and attractive writer and speaker, he was forceful, witty and adept in producing unexpected similes.

A knighthood was conferred on Bland-Sutton in 1912, which was followed by a baronetcy in 1925, and he served as president of the Royal College of Surgeons of England during 1923–26. He had now reached the summit of his surgical career and fame and of his ambition. As an operator he was incredibly quick and used the minimum of instruments. In profile he bore a marked resemblance to Napoleon, and he had many Napoleonic traits in his mental make-up, such as self-reliance, ambition, natural leadership of men, coolness in a crisis, and aloofness of personality. His beautiful dining-court in Brook Street, an exact replica in miniature of the hall of honour in the

palace of Darius the Great at Susa, was one of the sights of London and the frequent scene of lavish dinners, which were attended by the greatest men and women in the land.

Bland-Sutton was a keen traveller and made some fifty voyages to various parts of the world, which he described in memorable books and essays, such as "Man and Beast in Eastern Ethiopia", "Spolia Nemoralia" (an account of the shrunk heads of the Aguaruna Indians), and "The Science of the Bull-ring". He retired from the Middlesex Hospital in 1920 and died on December 20, 1936, at the age of eighty-one. When he started on his career, the path to surgery lay through the dissecting room. Foreseeing "the need of a more intimate association between the care of living patients and the study of disease" and anticipating the day when the path to surgery would lie through the pathological institute, in 1913 he presented to the Middlesex Hospital the Bland-Sutton Institute of Pathology. It is fitting that his ashes rest in the museum of this Institute, near his marble bust by Sir George Frampton: "A Seeker after Knowledge that should Avert or Mitigate Pain".

THE PROPERTIES OF SOLID ARGON

A MEETING of the Low Temperature Group of the Physical Society, held on February 8, was devoted to the properties of solid argon. Dr. K. Mendelssohn presided, and in his opening remarks emphasized that the simplicity of the atomic structure of the inert gases makes them valuable instruments for the exploration of the general physical properties of matter.

Prof. G. O. Jones mentioned briefly some researches into the properties of solid argon in progress at Queen Mary College (University of London), and described in detail work being carried out by Mr. B. F. Figgins on the specific heat of solidified argon–krypton mixtures of simple atomic proportions (1 : 1 and 1 : 3). Argon and krypton are known to form solid solutions over the whole range of composition at temperatures somewhat below their melting points, and it is of interest to inquire whether at sufficiently low temperatures separation into two phases occurs or whether (for mixtures of these simple proportions) a super-lattice might be formed. If the energy w gained in mixing an AB pair, equal to $w_{AB} - \frac{1}{2}(w_{AA} + w_{BB})$ in the usual notation, is positive, separation into phases would be expected. If w is negative a super-lattice could be formed. Examination of this system might therefore provide sensitive information about the interatomic potential functions for argon and krypton.

In order to obtain an estimate of the temperature at which two phases or a super-lattice might appear, we may consider the van der Waals attractive potential only and neglect differences of size. The polarizability is then the chief factor of difference between A and B, and w_{AB} would be approximately equal to $\sqrt{w_{AA}w_{BB}}$ so that $w > 0$. The same conclusion follows from the results of detailed calculations due to R. A. Buckingham. We should not expect it to be modified if the repulsive potential were taken into account, so that separation into phases would appear to be favoured. (Differences of size would presumably be expected to favour separation into phases as opposed to the formation of a super-lattice.) Making use of the known heats of sublimation, we estimate that w might be about 40 cal./mole, so that separation into phases might be expected somewhere between 10° and 40° K.

Careful measurement of the specific heat of the 1 : 1 mixture between 10° and 90° K. shows no discontinuity of any kind. The values lie intermediate between those reported by Clusius for pure solid argon and krypton respectively, but slightly above the mean values corresponding to any temperature. A redetermination of the values for the pure elements by Mr. Figgins now in progress suggests that C_p for the 1 : 1 mixture is equal to the mean of its values for argon and krypton within the limits of experimental error. Thus there appears to be no contribution to C_p from the disordering process, either in one or two phases. It is hoped that further information as to the state of order of the system will shortly be obtained by the use of X-rays. Meanwhile, it is of interest that Mr. R. Heastie (of Queen Mary College) has observed a positive deviation from ideality for solid solutions of argon and krypton, because such behaviour implies, for regular solutions, that w is greater than zero.

Prof. C. Domb gave a critical review of the methods of deriving information about intermolecular forces. There are three main sources of information: theoretical, gas data and solid-state data. Theory could provide a qualitative description of the form of the intermolecular potentials. At large distances the van der Waals attraction is represented by a series $-a/r^6 - b/r^8 - c/r^{10} \ldots$ (Casimir and Polder have indicated[1] that the series should start with $1/r^7$, but the matter is not completely clarified.) At short distances the repulsive force is of the form $P(r)\exp(-\alpha r)$, where $P(r)$ is a polynomial. Detailed calculations are very complicated, however, and even for the simplest substance, helium, it is likely that estimates based on experimental data are more reliable than the famous Slater–Kirkwood potential[2].

In regard to the gaseous state, it is customary to make use of the second virial coefficient and transport properties. While the information thereby provided is valuable, it is not sufficient to determine the precise form of the intermolecular potential, and the repulsive portion is particularly uncertain.

More extensive information is provided by data on the solid state. The sublimation energy and equilibrium volume at the absolute zero are sufficient to dispose of two parameters in any proposed formula for intermolecular potentials. Further information is now becoming available as a result of the accurate measurements of elastic constants at Queen Mary College, and the accurate determination of Debye θ values at low temperatures by R. W. Hill at Oxford. A recent series of measurements by Dr. C. A. Swenson at the Massachusetts Institute of Technology giving solid-state isotherms at pressures up to 4,000 atmospheres (I am indebted to Sir Francis Simon for providing me with these data) seems to open up the possibility of accurate information on the repulsive part of the intermolecular potential (these have recently been published: Stewart, J. W., *Phys. Rev.*, **97**, 578; 1955); this is being investigated by I. J. Zucker at King's College, London. Finally, the melting curve data at high pressures obtained at Oxford by Robinson and Simon clearly contain information about the repulsive potentials; but this can only be extracted if the Lindemann melting formula or some equivalent can be reliably established for high pressures.

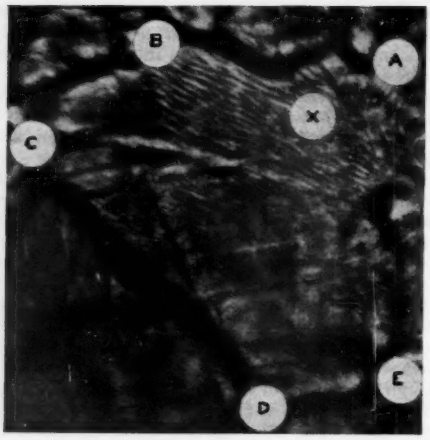

Fig. 1. Thermally etched surface of solid argon, showing a grain boundary *ABCDE* and striations, particularly in the region to the left of *X*. Magnification: the width of the photograph is approximately 3 mm.

In order to make effective use of the data on elastic constants, detailed calculations are required of the lattice dynamics of the face-centred cubic lattice, and this problem has been investigated recently by Barron and Domb[3].

Dr. E. R. Dobbs presented an account of some measurements of the elastic properties of solid argon derived from a study of the velocities of sound in polycrystalline specimens. A preliminary investigation[4] had shown that it was possible to obtain a compact, transparent solid of grain-size about 0·1 mm. by slowly depositing the argon from the vapour phase on to a surface cooled below the triple point (83·8° K.) of argon. This technique was used to grow a short cylinder of solid argon on one face of a gold-plated quartz crystal, one inch in diameter. The rate of growth was such that the solid argon increased in thickness by about 1 mm. every 10 min.

The quartz crystals used had an active area of about 2 cm. diameter and propagated continuously a plane wave of sound of wave-length (λ) in the solid argon of about 1 mm. This sound was reflected at a prepared flat solid/vapour interface and produced the usual resonance in the quartz crystal when standing waves arose in the argon. Accurate measurement of a number of positions of resonance, $\lambda/2$ apart, was achieved by stopping the growth of the argon when a resonance position had just been passed and then slowly cutting into the argon with a special tool the position of which was controlled by a micrometer screw.

The velocities of longitudinal (V_L) and of transverse (V_T) waves in solid argon were measured in this way to better than 2 per cent, using respectively 1 Mc./s. *X*-cut and 600 kc./s. *Y*-cut quartz crystals. These velocities, and an estimate[4] of the density (Δ) of solid argon, enable the adiabatic compressibility ($\varkappa_s$) and Poisson's ratio (σ) to be calculated. Using the specific-heat values of Clusius[5], the isothermal compressibility ($\varkappa_T$) has also been computed. The results are given for three selected temperatures in the range covered by the experiments in the following table, where $\varkappa$ is in cm.^{2} dyne^{-1} units:

T (°K.)	Δ (gm./c.c.)	V_L (m./s.)	V_T (m./s.)	$\varkappa_S \times 10^{10}$	$\varkappa_T \times 10^{10}$	σ
60	1·63	1,410	770	0·51	0·53	0·29
70	1·62	1,380	735	0·52	0·55	0·30
80	1·61	1,305	705	0·60	0·65	0·30

Preliminary theoretical calculations give results in reasonable agreement with experiment[3], but a more detailed investigation is being undertaken by T. H. K. Barron.

Dr. R. Followell described some recent experiments at Bristol designed to investigate the plastic properties of solid argon crystals.

The method of crystal growth, which was developed by Dr. D. Stansfield, is a modification of Bridgman's method in which a column of liquid is cooled slowly from one end, so that the solid–liquid interface moves gradually up the column. A growth-rate of 3–4 cm. an hour produces a polycrystalline specimen with an average grain-size of 2 mm., including grains of up to 6 mm. The specimen is grown in a rectangular tube with bulbous ends. The polycrystalline mass is detached from the walls of the specimen tube by judicious manipulation of temperature gradients.

Since the surface of the argon is then free, and at a temperature which is only of the order of 10° C. below the triple point of argon, thermal etching takes place and reveals the grain-boundaries, as shown by the line *ABCDE* in Fig. 1.

One of the objects of this research is to study the plastic properties of solid argon, including the phenomenon of slip. For this purpose the crystal is grown around a movable anchor, situated in one end of the specimen tube. The other end of the specimen is held by its bulbous end and so, by moving the anchor, tensile stresses may be applied to the central part of the specimen. An estimate of the strain is obtained by measuring the movement of the anchor. The observation of slip, however, was somewhat confused by the presence of thermally etched wavy striations caused by surface migration of the argon and shown in Fig. 1. In spite of this, slip has been unambiguously identified. Fig. 2*a* shows part of a grain one second before a stress was applied to the specimen, and Fig. 2*b* shows the same area five seconds after the stress was applied—a series of parallel straight lines are visible in Fig. 2*b* and must

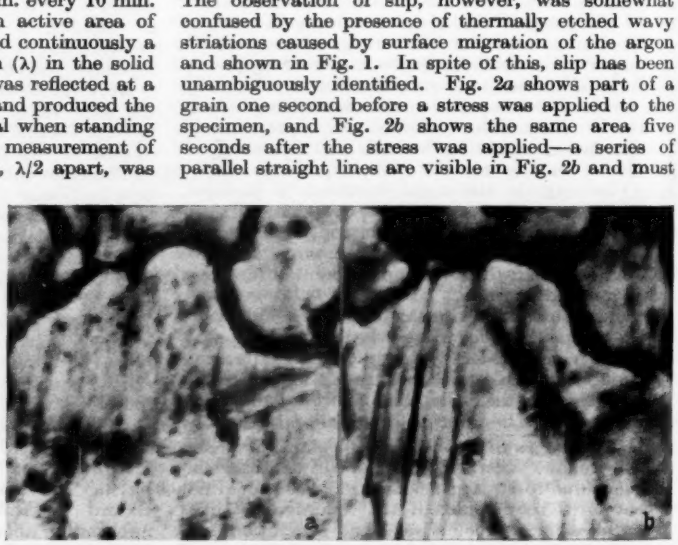

Fig. 2. Part of the surface of a grain in solid argon (*a*) before and (*b*) after slip—the slip lines (left) are approximately vertical. Magnification: the width of the photograph is approximately 2 mm.

be slip lines, because the establishment of thermally etched striations takes considerably longer than six seconds.

Preliminary quantitative observations on the plastic properties of solid argon have included measurements of the ultimate stress as a function of temperature. The programme of future research includes a further study of the slip process, efforts to obtain single crystals, measurements of the creep-rate at liquid oxygen temperatures and below, a quantitative study of grain-boundary movements during grain growth and measurements of the elastic constants of solid argon.

C. DOMB

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[3] Barron, T. H. K., and Domb, C., *Phil. Mag.*, **45**, 654 (1954); *Proc. Roy. Soc.*, A, **227**, 447 (1955).
[4] Barker, J. R., Dobbs, E. R., and Jones, C. O., *Phil. Mag.*, **44**, 1182 (1953).
[5] Clusius, K., and Weigand, K., *Z. phys. Chem.*, B, **46**, 1 (1940).

OBITUARIES

Sir Alexander Fleming, F.R.S.

SIR ALEXANDER FLEMING, the discoverer of penicillin, died suddenly on March 11 at his home in London with a heart attack at the age of seventy-three.

Alexander Fleming, the son of a farmer, was born near Darvel in Ayrshire, Scotland, on August 6, 1881. He received his early education at the village school and at Kilmarnock Academy. His father died when he was seven years old, and at thirteen years of age Alexander and his brother Robert were sent to live in London with a doctor brother who practised as an oculist in Marylebone Road. He continued his education for two or three years by attending the Polytechnic Institute in Regent Street, and then for four years worked in a shipping office. However, his doctor brother encouraged him to take up medicine, and with the help of a small legacy he became a student at St. Mary's Hospital Medical School, where he won the senior entrance scholarship in natural science. He showed that he had found his true bent by winning practically every class prize and scholarship during his student career. He qualified in 1906 and took his M.B., B.S. of the University of London in 1908 with honours and the gold medal.

In 1906 Fleming had begun to assist Almroth Wright in the Inoculation Department at St. Mary's Hospital, and he continued to work in the same Department for the rest of his life with the exception of an interlude during the First World War.

In 1928 he was appointed professor of bacteriology in the University of London, and he retired with the title of emeritus in 1948, but continued as the principal of the Wright–Fleming Institute of Microbiology until the end of last year. He was busily occupied with lecture tours and laboratory work to the end.

Fleming never ceased to pay tribute to the inspiring leadership of that great bacteriologist, Sir Almroth Wright, with whom he worked for nearly forty years. There is little doubt that in the early years he, like other assistants—and they were a distinguished team—was to a considerable extent the apprentice of Almroth Wright, whose dominant personality and fertile brain directed the general research programme of the Inoculation Department for many years. But even in the early days, Fleming showed his ingenuity and originality in devising simple apparatus and techniques for tackling laboratory problems. The First World War directed his attention to wound infection and its control; he was one of the first to show that most wounds become infected *after* admission to hospital. As Wright's disciple, he took an active part in the controversy on the physiological versus chemical treatment of wounds, and again his inventiveness in devising apparatus and experiments to test the validity of a hypothesis or statement was very well demonstrated. This work led on to one of his classical experiments, in which he showed that carbolic acid when added to blood in certain concentrations killed the leucocytes but not the pathogenic germs, so that the antiseptic actually helped rather than hindered bacterial multiplication.

In 1922 came the discovery of lysozyme. Following an observation that his own nasal secretion after a common cold had an inhibitory action on some of the bacteria present in the nose, he showed that this lytic substance was present in many tissues and secretions of the body and was also widely distributed in Nature. But, because it was not particularly active against pathogenic organisms *in vitro*, the medical world did not give it the attention it deserved. His work with lysozyme prepared the way for the epoch-making discovery of penicillin.

Fleming had been studying variation in the staphylococcus, which meant that he was frequently examining colonies of that organism as they appeared on ordinary nutrient agar. As a result of this exposure, a mould appeared on the culture medium some days later and Fleming noticed the unusual phenomenon of the disappearance of staphylococcal colonies around the mould. His first paper describing his work with the active principle of this mould, which he named penicillin, shows that he appreciated the great potentialities of this substance as a new kind of antiseptic.

Fleming was a reticent and rather taciturn man, with great independence of mind and strength of character. He was a born naturalist, keenly observant of everything around him, and always ready to devise and test new methods for studying germs in the laboratory or seeds and plants in the garden. He accepted the many honours that were showered upon him with slightly amused modesty. The simple kind of tribute touched him most, such as a collection of signatures or a letter from a child or from some poor person who had benefited from penicillin. Freed from administrative duties, he had been looking forward to working again with his beloved phagocytes and lysozyme, for the natural defences of the body were his abiding interest; now, instead, we mourn the loss of a great scientist.

ROBERT CRUICKSHANK

Prof. A. L. Dixon, F.R.S.

ARTHUR LEE DIXON died at Folkestone on February 20 at the age of eighty-seven. He was the son of the Rev. G. T. Dixon, Wesleyan minister of Northallerton, and was educated at Kingswood School, Bath. He was a scholar of Worcester College, Oxford, and his long and distinguished career is summarized in the appointments he held: in 1891 prize Fellow of Merton, in 1898 tutorial Fellow of that college, in 1922 Waynflete professor of pure mathematics and professorial Fellow of Magdalen

College, Oxford. He was elected to the Royal Society in 1912 and was president of the London Mathematical Society in 1924–25.

In 1945, on his voluntary retirement from the Waynflete professorship (for his was a pre-commission appointment), he was elected by Magdalen College to a supernumerary non-stipendiary fellowship, an appointment but rarely made and a very great tribute to Dixon's personal quality: colleges do not lightly award fellowships, with rooms and dining rights, to retiring professors in their late seventies.

Dixon's research career as a mathematician was long and varied. He wrote on algebra, algebraic geometry, pure geometry and elliptic functions; then, beginning a seven-year series when he was sixty-two years of age, published papers in collaboration with the present writer on Bessel functions and summation formulæ. He was no believer in compelling every promising young man to embark on research: he was himself an example of how a man must carry out research if his mind is made that way.

Dixon's physical prowess and accuracy of eye were unusual, especially in the way he retained them to a late stage of his career; when he was nearly seventy it was not easy to beat him at squash, and even with seventy behind him he could still normally defeat several of his younger colleagues. But it is not for his hockey, tennis, squash or croquet skill that one admires Dixon most; nor even his musical knowledge and skill, nor yet his facility in foreign tongues: the thing about him that one recalls first and admires most is the slightly old-world courtesy and charm that permeated his every social contact. It was as completely natural to him as his physical strength or his mathematical power: it endeared him to many friends and made him a welcome visitor wherever he went.

W. L. Ferrar

NEWS and VIEWS

Glass Technology at Sheffield:

Prof. Harry Moore

Prof. Harry Moore, who is retiring from the chair of glass technology in the University of Sheffield, began his career in the University of London as a lecturer in physics. During this time he studied the effects of homogeneous X-radiation on a variety of materials and also wrote (with H. S. Allen) his "Textbook of Practical Physics", which was followed later by the "Textbook of Intermediate Physics". After the First World War he was appointed assistant director (later director) of research of the British Scientific Instrument Research Association, where he was able to use to the full his capabilities as an administrator and leader of a powerful research team. Prof. Moore had long been interested in glass, and the invitation, which he accepted in 1937, to become director of research for Messrs. Pilkington Bros., Ltd., enabled him to turn his attention to the many problems of modern, large-scale glass manufacture. In 1945 he went to Sheffield in succession to Prof. W. E. S. Turner. He was president of the Society of Glass Technology in that and the previous year. His recent work has been primarily concerned with the colouring and decolorizing of glass in relation to its structure. He has conducted spectrophotometric studies and also investigations into the magnetic and electrical properties of glasses, all of which have provided valuable information on the role of iron in colouring glasses. Internationally known for his work in glass technology, Prof. Moore is particularly distinguished for his capabilities as a lecturer; his ability to explain intricate problems in lucid terms has delighted many audiences.

Prof. R. W. Douglas

Prof. Moore is being succeeded by Mr. R. W. Douglas, who has pursued his scientific career as a member of the G.E.C. Research Laboratories, which he joined in 1927. After some early work on the measurement of the physical properties of glass, he became concerned with more fundamental problems such as the relation between the physical properties and basic structure of glass and the similarity in behaviour between glass and the liquid phase in respect of such properties as density, thermal expansion and viscosity. He is now well known as an authority on the physics of glass, and his many publications on the subject have enriched the literature in this field. From about 1946, Mr. Douglas extended his activities to include participation in the field of semiconductor physics. A primary concern with the semiconductor materials themselves and their physical properties led to an interest in the physics of the solid state generally. Among the projects for which he has been responsible have been the development of new semiconducting materials and the elucidation of the properties of semiconductors on the grounds of both theory and experiment. In recent years, Mr. Douglas has contributed to several international meetings concerned with the physics of semiconductors. In spite of this later change in his activities, Mr. Douglas has retained his interest throughout in all matters concerned with glass technology and the physics of glass. He has served on technical committees of the Society of Glass Technology and since 1949 has been honorary secretary of that Society.

British Glass Industry Research Association

A new research association, the British Glass Industry Research Association, has been formed and has started work at "Elmfield", Northumberland Road, Sheffield, with Dr. R. G. Newton as director of research, and Dr. D. K. Hill as assistant director. Unlike other newly formed research associations, this one does not have to inaugurate its research, for it will take over from the Department of Glass Technology of the University of Sheffield and will thus continue the tradition of research work begun there during the First World War. During the past few years it has become evident that the demands from industry on the time of the professor at Sheffield have become so great that it is essential to divide the work previously carried out into two portions: a University teaching department, which will also carry out research; and a research association which will carry out all the functions for industry of consultation and remedying troubles, together with research for industry. The new arrangements have

now been made, and the British Glass Industry Research Association and the Department of Glass Technology are separately administered, although they share the same University buildings at "Elmfield". For the Research Association, industry will subscribe a minimum of £20,000, while the Department of Scientific and Industrial Research will grant £10,000 a year with an extra £100 for each £100 that industry subscribes above the minimum. On the University side, the University sources will provide the bulk of the money required to run the Department of Glass Technology, but manufacturers have undertaken to continue to give financial support to the Department worthy of its position as a source of well-equipped scientific and technological personnel.

Dr. R. G. Newton

THE new director of research of the British Glass Industry Research Association, Dr. R. G. Newton, who was born in 1912, took his Ph.D. and D.I.C. for botanical work at the Imperial College of Science and Technology, London, and later worked on the physiology of latex for the Rubber Growers' Association. He entered the Research Association of the British Rubber Manufacturers in 1938 as a research assistant and was appointed head of the Research Division in June 1940. After the Second World War, Dr. Newton's work was particularly associated with the use of modern statistical methods in research analysis. Towards the end of 1948 he joined the British Rubber Producers' Research Association and two years later was appointed co-ordinating officer for technically classified rubber, on behalf of the International Rubber Research Board. This involved general co-ordination of new development and the producers' interests, and his responsibility for general liaison between producers and consumers resulted in wide travelling in Malaya, Indo-China, Indonesia and the United States. In July 1953 he was appointed deputy secretary of the International Rubber Research Board and the International Rubber Development Committee, and continued to co-ordinate the international aspects of technically classified rubber. The work on which Dr. Newton will be engaged is in an entirely new field; but he will carry with him a wide administrative experience formed from his work with two important research associations.

Civil Engineering at Sheffield : Prof. N. S. Boulton

SINCE 1936 the three University Departments of Mechanical, Civil and Electrical Engineering of the University of Sheffield have been under one professor of engineering, each Department being directed by a senior lecturer. Separate chairs of civil engineering and electrical engineering have recently been created, and Mr. N. S. Boulton, senior lecturer in charge of the Department of Civil Engineering, has been appointed to the newly created chair in that Department. Mr. Boulton is a graduate in civil engineering in the University of Birmingham; he remained at Birmingham for a further two years carrying out research, for which he was awarded the degree of M.Sc. and the Dudley Docker Research Scholarship. After five years professional experience in the Public Works Department of the City of Birmingham, and seven years lecturing experience at King's College, Newcastle upon Tyne, in 1936 he was appointed senior lecturer in charge of the Department of Civil Engineering at Sheffield, and is now deputy dean of the Faculty of Engineering. Prof. Boulton is the author of several papers in the field of hydraulic flow, plasticity and stress analysis.

Director of Experimental Centres of the National Agricultural Advisory Service

THE Ministry of Agriculture and Fisheries has recently announced the creation of a new post in the National Agricultural Advisory Service, namely, that of director of experimental centres, and Mr. P. J. Macfarlan, at present deputy provincial director for the Yorkshire and Lancashire Province, has been appointed to fill it. The post is graded at the level of provincial director, and the holder will work at the headquarters of the Service in London. The principal duty of the director of experimental centres will be to supervise and control the experimental work at the experimental husbandry and horticulture centres, and this he will do under the direction of the senior advisory officers and in close association with the Experimental Husbandry and Experimental Horticulture Committees (and Sub-Committees) of the Agricultural Improvement Council, to which he will act as convenor. His duties will also include the general supervision and co-ordination of the field experimental work at provincial centres and in the counties, and responsibility for the collection, tabulation, examination and preparation for publication of the results of experiments.

The Parliamentary and Scientific Committee: Report for 1954

THE annual report for 1954 of the Parliamentary and Scientific Committee (pp. 24; from the Committee, London; 1955), besides the usual list of subscribing members and brief report of the annual general meeting, gives a list of addresses and discussions before the Committee during the year, most of which have already been noted in *Nature*. It includes also a summary of the report of the sub-committee on higher technological education and of the main points made by the Lord President of the Council in a House of Lords debate on the subject. At a meeting of the Committee on December 7, it was agreed that the sub-committee should be maintained in being to advise what further recommendations should be made to the Government with regard to the implementation of the plans outlined by the Lord President. Several members of the Committee specially supported the President of the Board of Trade in the second reading of the Development of Inventions Bill on January 26, 1954. During the year a small sub-committee was set up, with Sir Harold Roper as chairman, to consider whether any action was called for in connexion with the report of the Faulkner Committee on the Prevention of Pollution of the Sea by Oil. As a result of several meetings and consultations with experts, a resolution was submitted to, and passed by, the Parliamentary and Scientific Committee, recommending that the Lord President of the Council should, in consultation with the Minister of Transport and other Ministers concerned, arrange for the early appointment of a small committee to ensure that all necessary research work relating to the pollution of the sea by oil is put in hand forthwith and co-ordinated with any relevant current research work, and suitable arrangements made for its implementation. It is understood that the Oil Pollution Committee afterwards set up by the Government is taking special steps to deal with the various aspects of research involved, and its chairman has informed Sir Harold Roper that the

Committee is in broad agreement with the Parliamentary and Scientific Committee's recommendations as to matters for further research. Questions of fuel efficiency and the building programme of the Department of Scientific and Industrial Research were also raised in Parliament during the year.

Society for Analytical Chemistry

The eighty-first annual general meeting of the Society for Analytical Chemistry was held in London on March 4, when the financial statement and the report of the Council for the past year were submitted and approved. The membership of the Society was reported as being 1,799—an increase of 153 since last year. In addition to five ordinary meetings in London (two of which were organized by the Biological Methods Group and one by the Microchemistry Group), a joint meeting with the Oils and Fats Group of the Society of Chemical Industry, and twenty-one meetings held by the Society's various Sections and Groups, the Society organized two special meetings in London as follows: one on the use of perchloric acid in analytical chemistry, at which a paper was read by Prof. Harold Burton and Dr. P. F. G. Praill, and one by Prof. G. Frederick Smith (University of Illinois); and the other, at which Prof. G. Schwarzenbach (University of Zurich) spoke on the complexones and their analytical applications, and Dr. H. M. N. H. Irving gave demonstrations.

At the annual general meeting of the Society the following officers and members of Council were elected for the forthcoming year: *President*, K. A. Williams; *Past Presidents serving on the Council*, Lewis Eynon, D. W. Kent-Jones, J. R. Nicholls and George Taylor; *Vice-Presidents*, C. A. Adams, D. C. Garratt and H. M. N. H. Irving; *Honorary Treasurer*, J. H. Hamence; *Honorary Secretary*, N. L. Allport; *Other Members of Council*, D. C. M. Adamson, C. H. R. Gentry, J. Haslam, C. L. Hinton, W. C. Johnson, A. G. J. Lipscomb, T. McLachlan, R. F. Milton, Miss Mamie Olliver, S. A. Price, R. E. Stuckey and C. Whalley; *Ex-officio Members*, J. R. Walmsley (chairman, North of England Section), F. J. Elliott (chairman, Scottish Section), H. J. Evans (chairman, Western Section), J. R. Leech (chairman, Midlands Section), G. F. Hodsman (chairman, Microchemistry Group), A. A. Smales (chairman, Physical Methods Group) and L. J. Harris (chairman, Biological Methods Group).

Models of Molecular Structure

Many research workers have been aware of the value of the space-filling atomic models developed by G. S. Hartley and C. Robinson at the Maidenhead Laboratory of Courtaulds, Ltd. These models are now available commercially from the firm of Griffin and Tatlock (Kemble Street, Kingsway, London, W.C.2). Primarily designed for research, where accurately made models are required from which quantitative deductions of molecular geometry can be made, the models are also eminently suitable for lecturing purposes. Their large size (scale 0·8 in. to 1 A.) and comparative 'transparency' make even complicated structures easy to follow. The bond angles, covalent radii and van der Waals radii of the atom models are based on currently accepted values. When the arrangement involves only δ-bonds the models are designed by cutting back spheres, of radii equal to the van der Waals radii, in the direction of each valency bond, by an amount which leaves the distance from the atom centre to the middle of the link equal to the appropriate covalent radius. For those atoms forming bonds involving π-electrons, the van der Waals radius will be longer in a direction normal to the bonds as a consequence of the π-electron orbitals. Account has been taken of this factor. A notable feature of the design is the arrangement of brass link and rubber collar by which the models are joined together. This provides elastically distortable valency angles so that many molecules can be built, including those with strained rings, which cannot be constructed with a rigid linking mechanism. At the same time there is no sacrifice of free rotation about single bonds, while large molecules can be handled without falling apart. Important contributions to peptide and protein chemistry have already been made with the aid of these models. It is likely that their application in other fields will be equally fruitful.

Indian Council of Ecological Research

In order to promote and expand ecological studies on Indian vegetation, an Indian Council of Ecological Research has recently been set up and will hold its first meeting at the Forest Research Institute, Dehra Dun, later this year, when plans will be made for the execution of ecological studies in relation to forestry, agriculture, desert control, soil conservation, flood control, etc. The heads of forest departments of all States of the Union and vice-chancellors of all Indian universities have been requested to send a note describing the type of ecological research at present being conducted and whether they will be able to participate in the work of the Council. With the information so collected, the Council will select places for the setting up of small experimental stations for ecological research in collaboration with a particular university or State forest and agricultural departments. The Council also expects to arrange at Dehra Dun a short course in techniques and methods in ecological research for students, teachers and other workers engaged in ecological research. The Council consists of the following officers together with twelve members: *Chairman*, Shri C. R. Ranganathan, inspector-general of forests, New Delhi; *Vice-Chairmen*, Shri K. L. Aggarwal, president of the Forest Research Institute and Colleges, Dehra Dun; and Father Santapau, chief botanist, Botanical Survey of India, Calcutta; *Secretary*, Dr. G. S. Puri, ecologist, Forest Research Institute, Dehra Dun. All inquiries should be directed to the secretary at P.O. New Forest, Dehra Dun, U.P.

Pectic Enzymes

In a further contribution to the physiology of parasitism, R. K. S. Wood (*Ann. Bot.*, N.S., **19**, 1; 1955) has investigated the pectic enzymes secreted by *Bacterium aroideae*. He has shown that cell-free filtrates from cultures of this organism on a simple synthetic medium contained an enzyme, that he has provisionally called 'depolymerase', which has the property of reducing rapidly the viscosity of pectin solutions. The filtrate also contained protopectinase which macerated slices of potato tuber. The filtrates, however, had little pectin-esterase activity. The activity of the depolymerase was found to be directly proportional to the enzyme concentration; that of the protopectinase was approximately proportional to the square root of the enzyme concentration. Partial purification of crude solutions was effected by acetone or ethanol precipitation. The various

properties of the enzyme preparations and of the depolymerase have been investigated and results recorded. The differences between the pectic enzymes of *B. aroideae* and those from other sources, and the possible identity of depolymerase, polygalacturonase and protopectinase, are discussed.

Symbiotic Systems for Nitrogen Fixation

G. Bond and G. D. Scott have been able to demonstrate, by using nitrogen-15, the occurrence of fixation of elemental nitrogen in the lichens *Collema granosum* and *Leptogium lichenoides*, in both of which *Nostoc* is present as the algal component (*Ann. Bot.*, N.S., **19**, 65; 1955). A similar result has been demonstrated in the liverwort *Blasia pusilla* in which *Nostoc* is present in thallus cavities. The indications are that *Nostoc* is the agent responsible for the nitrogen fixation. In the same investigation, no evidence was obtained of nitrogen fixation on the mycorrhizal roots of intact plants of *Calluna vulgaris* or of *Pinus sylvestris*, both of which, but especially the former, have been held by previous investigators to be capable of nitrogen fixation.

Zoological Nomenclature

NOTICE is hereby given that, as from August 28, 1955, the International Commission on Zoological Nomenclature will start to vote on the following cases involving the possible use of the plenary powers for the purposes specified against each entry. Full particulars of these cases were published on February 28, 1955, in Parts 3 and 4 of Vol. 11 of the *Bulletin of Zoological Nomenclature*. (1) *Entomobrya* Rondani, 1861 (Cl. Insecta, Order Collembola), validation of; (2) *Iphis* Leach, 1817 (Cl. Crustacea, Order Decapoda), validation of (correction of error in Opinion 73); (3) *Homalaspis* Milne Edwards (A.), 1863 (Cl. Crustacea, Order Decapoda), validation of (correction of error in Opinion 85); (4) *Monticulipora* d'Orbigny, 1849 (Cl. Bryozoa), designation of type species for; (5) *obscura* Berezowsky and Bianchi, 1891 (*Larvivora*) (Cl. Aves), validation of; (6) *bei* Ridgway, 1874 (*Eremophila alpestris* var.), suppression of; (7) *dingo* Meyer, 1793 (*Canis*) (Cl. Mammalia), validation of, as the name for the dingo; (8) *Bombina* Oken, 1816 (Cl. Amphibia, Order Anura), conservation of; (9) *Scolopendra* Linnæus, 1758 (Cl. Myriapoda), designation of type species for. Proposals are also made for the adoption of two 'Declarations': (*a*) clarifying Rule (*g*) of Article 30, relating to the selection of the type species, in cases where a species has two or more names objectively synonymous with one another; (*b*) regarding the specific name to be adopted for the type species of a genus in cases where that species possesses two or more objectively synonymous such names. Comments should be sent as soon as possible to Francis Hemming, secretary to the Commission, 28 Park Village East, Regent's Park, London, N.W.1.

Biochemical Periodicals in Poland

THE successful reorganization of teaching and research activities in Polish biochemistry is well illustrated by the publication of no fewer than three new journals sponsored by the Polish Academy of Sciences in Warsaw, and devoted largely to biochemistry. *Postępy Biochemii* (*Progress in Biochemistry*) is edited by Prof. J. Heller, and consists of review-articles based on symposia organized periodically by the Biochemical Committee of the Academy. The latest issue (No. 2) reports on two such symposia, one on clinical biochemistry, with contributions by W. Mozolowski and Z. Stolzmann, among others; the other on plant biochemistry and chemical mycology. *Acta Biochimica Polonica* is a quarterly, devoted entirely to original papers, written in Polish, but with extensive summaries in both Russian and English. Volume 1 includes among its thirteen papers several original contributions on blood biochemistry (including one by Skarzynski and another one by Mozolowski) as well as some extensive analytical studies on purine bases by Dmochowski. *Bulletin de l'Académie Polonaise des Sciences, Classe Deuxième*, covers the whole field of biological and medical sciences and consists of papers communicated by members of the Academy. A recent issue (Vol. 2, No. 2) contains ten papers (all in English), of which three are biochemical, one by Galos and Ostrowski on the electrophoretic separation of carbohydrates, another by Zakrzewski *et al.* on physicochemical properties of dextran, and a third by Shugar and Syruczek on lysozyme, mainly on the kinetics of its inactivation by heat.

Van de Graaff Generator at the Weizmann Institute of Science, Rehovoth

A 3-MV. Van de Graaff positive-ion accelerator is being constructed specially for the Weizmann Institute of Science, Rehovoth, Israel, by the High Voltage Engineering Corporation of Cambridge, Mass., and, when installed, will be used at the Institute for studying nuclear reactions produced by the bombardment of the nuclei with high-energy protons. Dr. Gvirol Goldring, of the Weizmann Institute's Department of Nuclear Physics, is going to the United States, where he will take part in the construction of the Van de Graaff generator and be responsible later for its assembly, installation and operation at Rehovoth. He will spend some time at the Massachusetts Institute of Technology making himself familiar with the details of a similar generator already installed there. The new generator is due to be completed in the United States in December 1956 and to be installed in the new building of the Nuclear Physics Department at the Weizmann Institute in May 1957. Work on the building is scheduled to begin later this year as part of the Yad Chaim Weizmann programme of scientific and cultural development. On his way to the United States, Dr. Goldring, who is twenty-seven years old, is spending a month in France at the University of Strasbourg, where he has been invited by the Physics Department there to assist in drawing up an advanced programme connected with the Van de Graaff accelerator recently acquired by it.

Wool Textile Research Conference in Australia

A NUMBER of scientific workers of international reputation in wool research and related fields of study have been invited to attend a research conference on wool textiles, to be held in Australia during August–September under the auspices of the Commonwealth Scientific and Industrial Research Organization. Besides giving them the opportunity to discuss the latest developments in their particular topics, the conference will also enable members to see the advances that have been made in Australian research laboratories and to make contacts with Australian research workers. The members will be able to visit the C.S.I.R.O. wool textile research laboratories, which are situated in three of the principal Australian wool-manufacturing centres and comprise a bio-

logical chemistry laboratory in Melbourne, known as the Biochemistry Unit, the Physics and Engineering Unit in Sydney, and a Unit at Geelong studying wool textile processing. In addition, the Gordon Institute of Technology at Geelong and the recently established New South Wales University of Technology in Sydney have extensive facilities for wool textile research, and also the C.S.I.R.O. Division of Industrial Chemistry in Melbourne has for some years carried out investigations into the structure of proteins and the chemistry of wool wax. The conference will open in Sydney on the morning of August 22, and on August 26 the delegates will leave by road for Geelong, where sessions will be continued during August 31–September 2; the final sessions will be held in Melbourne during September 5–9. The programme will be in three parts: the chemistry and biochemistry of proteins (the structure information can be obtained from the Secretary, of keratin and the wool fibre); wool physics and fibre assemblies; and wool technology. Further International Wool Textile Research Conference, c/o C.S.I.R.O. Wool Textile Research Laboratory, 343 Royal Parade, Parkville, N.2, Victoria, or from the C.S.I.R.O. liaison offices in London and Washington.

Announcements

The spring conference of the Scientific and Technical Group of the Royal Photographic Society is being held at Reading on April 30. The detailed programme can be obtained from R. E. Withrington, 49 Kensington Avenue, Manor Park, London, E.12.

The Scottish Field Studies Association is arranging a conference on "Field Studies in Education", to be held in Glasgow on April 25, in Aberdeen on April 26 and in Edinburgh on April 27, with the proceedings commencing each day at 4.30 p.m. The opening address will be given by Mr. F. H. C. Butler, founder and educational adviser of the Council for the Promotion of Field Studies. The conference is especially for those professionally concerned with education and is designed to emphasize the need for field studies in education in Scotland. Further information can be obtained from the Honorary Secretary, Scottish Field Studies Association, Department of Botany, University, Glasgow, W.2.

The British Society of Rheology is holding a conference on "Visco-elastic Behaviour" in the Physics Department, King's College (University of Durham), Newcastle upon Tyne, during April 29–30. An exhibition of rheological apparatus is being arranged in conjunction with the conference. Further information can be obtained from Dr. E. G. Richardson, King's College, Newcastle upon Tyne.

The fifth conference of the International Society for the Study of Biological Rhythm will be held in the Department of Anatomy of the Caroline Institute, Stockholm, during September 15–17. The principal themes will be rhythmical phenomena in the nervous system; cybernetics; and rhythm and industrial medicine. Further information can be obtained from Prof. Ture Petrén, Karolinska Institutet, Stockholm 60.

A short course in chemistry for teachers from technical colleges, to be held at Wynyard Hall Training College, Wolviston, Billingham, County Durham, during July 18–27, is being arranged by the Ministry of Education. The course will be concerned with the chemical and other aspects of large-scale chemical manufacturing operations, with particular reference to the processes at the Billingham and Wilton works of Imperial Chemical Industries, Ltd. The fee for the course, which is residential, is £11. Applications, to be made on Form 106 *RSC*, must be sent in by April 30. Further information can be obtained from the Ministry of Education, Teachers Short Courses, 36–38 Berkeley Square, London, W.1.

The Edinburgh Mathematical Society is holding its annual colloquium in St. Andrews during July 13–23. The colloquium will consist of several short invited courses of lectures on topics of general interest to mathematicians, supplemented by a number of single lectures, most of which will be on more specialized subjects. The following will be lecturing: M. F. Atiyah (Cambridge), Prof. P. Hall (Cambridge), Prof. W. W. Rogosinski (Newcastle), Prof. E. Stiefel (Zurich), and Prof. J. L. Synge (Dublin). The fee for the course is 10 guineas (non-residents £1 12*s.* 6*d.*). Further information can be obtained from the colloquium secretary, Mr. J. R. Gray, United College, St. Andrews.

A course on "Biology and Civil Engineering", to be held in London during July 3–16, has been planned for overseas civil engineers by the British Council in co-operation with the Institution of Civil Engineers, with the object of imparting some of the recent developments which have taken place in Britain in the application of biological research to engineering problems. The programme is designed to be of particular interest to those specializing in water supply, sewage treatment, the control of pests, the preservation of timber and the effect of vegetation on structures. The fee for the course, which is fully residential, is £40. Applications should be made to the local British Council representative or to the Director, Courses Department, British Council, 65 Davies Street, London, W.1.

The Industrial Research Committee of the Federation of British Industries has organized a conference on "The Education and Training of Graduate Staff for Industrial Research", to be held at Ashorne Hill, near Leamington, during April 29–May 1. The speakers will include Sir Edward Bullard, director of the National Physical Laboratory; Prof. E. G. Cox, professor of inorganic and structural chemistry in the University of Leeds; Prof. J. A. Pope, head of the Departments of Civil and Mechanical Engineering in the University of Nottingham (first degree courses); Mr. C. Paine, director of Imperial Chemical Industries, Ltd.; Mr. O. W. Humphreys, director in charge of research, General Electric Co., Ltd. (selection and training); Prof. H. W. Melville, Mason professor of chemistry in the University of Birmingham; and Prof. A. J. S. Pippard, professor of civil engineering, Imperial College of Science and Technology, University of London (postgraduate training). Particulars can be obtained from Mr. G. Withers, Federation of British Industries, 21 Tothill Street, London, S.W.1.

A research scholarship worth £400 a year for two years is being offered by the Aluminium Development Association to encourage and facilitate research in the application of light alloys to ship construction. The scholarship will be administered by a committee of the Institution of Naval Architects, and it is hoped to make an award in September. Further particulars of entry, which closes on June 30, can be obtained from the Secretary of the Institution, 10 Upper Belgrave Street, London, S.W.1.

RESEARCH IN TECHNICAL COLLEGES

By Dr. F. HAPPEY

Head of the Department of Textile Industries, Bradford Technical College

THE question of the status of higher technology is a matter which has been exercising all levels of critical opinion in Britain. In all cases, however, it has been generally agreed that little progress in higher technological education can be made except it be in an institution which itself encourages technological research and development in the appropriate departments. In this field it is of interest to consider the progress in research which has been made in the Textile Department in the Bradford Technical College and some of the difficulties which have still to be faced in this work.

The Wool Textile Research Council was formed some years ago as a committee representative of the industry to collect a statutory levy from the wool industry and dispense the funds among the Wool Industries Research Association, the universities and the major technical colleges of the wool areas of Great Britain. Bradford Technical College draws a considerable sum of money from this body every six months, and together with other grants and scholarships from the City of Bradford, the International Wool Secretariat, the Rayon Research Federation, the Bradford Dyers' Association, Woolcombers, Ltd., and the local Hospital Management Committee, etc., has been able to draw up a wide and comprehensive research programme. This work is partially technological, that is, research and development work on spinning, weaving and designing is in progress, and also a scientific programme has been inaugurated dealing mainly with fibre structure and the growth and development of wool and other related tissues.

A team of research workers in the Department of Textile Industries has been collected during the past three years, and attempts have been made to recruit research Fellows and Scholars from as wide a field of training as possible. It is obvious that this is the best way to broaden the scope of the work and the outlook of the research student during and after his training period. To this end, during the past three years, a staff has been recruited as follows. (These include four members of the research teams who are carrying out work in the Department of Chemistry and Dyeing, and who, with other research workers outside the scope of this discussion, are under the general direction of Dr. R. L. Elliott, head of that Department): (*a*) four Research Fellows, from the Universities of Oxford, Manchester, Sheffield and London (Bradford external student); (*b*) eleven Research Scholars for scientific research, from Manchester, Sheffield, Liverpool, London (internal) and London (external); (*c*) five Research Scholars for technological research—one internal London graduate and four past diploma students of the Textile Department of the Technical College.

It is clear from the list of research workers, whose remunerations vary between £300 and £900 (approximately) a year, that the industry and local authority have carried out their commitments to the full and with a considerable sense of urgency. In point of fact, the specialized equipment is provided mainly by the Wool Textile Research Council, although it must be clearly understood that from the point of view of development work the education authority has during the past provided a complete range of pilot plants so that trials can be carried out in a routine manner in the spinning, manufacturing and finishing sheds of the Department. Thus, even before its expansion the Textile Department has had adequate equipment for certain of its anticipated research and development work. When, however, one considers the academic awards available to the students, the situation can at its best be described as chaotic and at its worst, farcical.

First, there is no fundamental difficulty for London graduates in submitting work for higher degrees. Secondly, in the case of non-London graduates, those from the civic universities can submit work for M.Sc., but are not acceptable to these institutions as Ph.D. students. In this way they are no more favourably placed than graduates working in industry, so that research in technical institutes with scholarship finance is only likely to attract a core of enthusiasts. The graduates from the older universities are in an even less enviable position; there is no research degree which they can attain.

Finally, for the diploma students the outlook is no more encouraging. All the students mentioned earlier with the primary qualification are eligible for the direct award of associateship of the Textile Institute two years after obtaining the diploma and when they reach the age of twenty-five years. Three of these students have already carried out sufficient research to submit the work for the award of fellowship of the Institute, essentially a research qualification, but the latter diploma cannot be held for some years after the student has been awarded the associateship qualification. (I am not in disagreement with the principle of the award of the associateship at twenty-five and fellowship at thirty (approximately), as many factors other than academic ability are involved in all such professional awards.) Thus, academically, students may well be of fellowship standard before they have reached the age barrier of associateship. Unfortunately, there is no award whatsoever which can give these technological research workers an academic designation of the standard which they have attained.

From the academic point of view, therefore, the provision of appropriate degrees is the final stage in the establishment of a school of textile research in Bradford Technical College. The standard of research work and the theses submitted by the research students of the College have been of a sufficiently high standard that up to the present no application for a higher degree has been rejected by the external examining bodies, from which it is reasonable to assume that the work is of an adequate standard. One might therefore ask, what is the difficulty?

No longer can the blame for the inadequate provision of opportunity be laid at the door of the City or the industry; it now appears to rest firmly on the shoulders of these bodies whose terms of reference include the authorization and institution of scientific and technical degrees and diplomas. I have directed attention to these anomalies and difficulties with some diffidence.

SMITHSONIAN INSTITUTION

ANNUAL REPORT FOR 1953–54

THE report of the Secretary of the Smithsonian Institution for the year ended June 30, 1954*, refers to the completion of a new exhibition hall, opened to the public on April 14, 1954, as the first installation of the programme of modernization and reconditioning of exhibitions in the Institution which during the next nine years should transform entirely the outmoded, inadequate and sometimes uninstructive features of the Smithsonian exhibitions so that they can be seen in a modern suitable setting. This first hall displays the development of the archæology of Central and South America before the coming of Columbus. Much progress was made during the year in developing detailed specifications for the new Museum of History and Technology, and further consideration has also been given to the buildings required for the National Zoological Park and the Natural History Building. The River Basin Programme was sharply curtailed, and the Secretary expresses anxiety lest, if funds are not made available next year, it will be forever too late to pursue the study of the early life of the original Americans, 80 per cent of whose important archæological remains are in river basins.

For further details of these surveys, the Secretary refers to the report of the Bureau of American Ethnology; this latter report and those of the other nine bureaux administered by the Institution, of the library, of the executive committee of the Board of Regents, and that on publications are appended. During the year 632,243 specimens were added to the collections in the United States National Museum, visitors to which numbered 3,262,150, and in which on an average at least a hundred scientists not on the Smithsonian staff are daily at work. Field-work was conducted in Thailand, Venezuela, Panama, the Caroline Islands, Fiji, Mexico, and many parts of the United States. Dr. M. W. Stirling, director of the Bureau of American Ethnology, continued his studies of Panamanian archæology, and Dr. H. B. Collins his Eskimo research and other arctic activities, including chairmanship of the committee supervising the preparation of the "Arctic Bibliography" for the Department of Defense. Studies of Olmec archæological materials from southern Mexico were continued by Dr. P. Drucker, while field activities in the river basin surveys consisted chiefly of reconnaissance or surveys to locate sites that will be involved in construction work or eventually submerged by reservoirs. By June 30, 1954, archæological surveys or excavations had been made since 1946 in 243 areas in 27 States and 4,345 archæological sites recorded, of which 852 were recommended for excavation or further testing. Activities of the Missouri Basin project were greatly reduced for lack of funds, but six field parties operated in the Basin during the year. In Tennessee detailed surveys were made of the Cheatham Lock and Dam and Old Hickory Lock and Dam projects on the Cumberland River near Nashville.

The Astrophysical Observatory completed work on the ninth revised edition of the "Smithsonian Physical Tables" and on Vol. 7 of the "Annals of the Astrophysical Observatory". Solar-radiation studies were continued at Table Mountain, California, and Mount Montezuma, in Chile; and besides routine work, calibrations were made of a silver-disk pyroheliometer for the Meteorological Service of Canada, a modified Ångström pyroheliometer for the Meteorological Service of the Belgian Congo, and a normal-incidence Eppley pyroheliometer for the United States Weather Bureau. The Division of Radiation and Organisms has shown that the apical stem hook is an excellent and reproducible test object for measuring the effect of radiant energy and chemical factors in the photomorphogenic response, and that triiodobenzoic acid, which opposes the effect of auxin in many other plant responses, produces an effect on the bean stem hook similar to that of the photo-reaction; studies have been completed of the effectiveness of various wave-lengths on the opening of the bean hook.

Progress was made in transport of the stored collections of the National Air Museum from Park Ridge, Illinois, to improved conditions at Suitland, Maryland, and three hundred and sixty specimens were added during the year. A special exhibit was arranged in December 1953 in connexion with the celebration of the fiftieth anniversary of powered flight, while the Museum's studies of the origin and history of the guided missile in the United States and of the pictorial history of the Wright brothers were materially advanced. Accessions to the National Zoological Park numbered 899 and visitors 3,616,220, but new buildings are urgently needed, as well as new paddocks. During the year twenty-two scientific workers went to the Canal Zone Biological Area for research, but the number of visitors decreased by a quarter.

The number of packages transmitted by the International Exchange Service decreased by 1,429 to 1,020,509; but 3,566 boxes, or 917 more than during 1952–53, were shipped to the foreign exchange bureaux, including sixty-two full sets and forty-three partial sets of United States government documents in exchange for official publications of foreign governments. Additions to the Library totalled 69,484 publications, and 515 new exchanges were arranged, while more than fifteen thousand reference questions were handled despite the fact that understaffing kept the bureau libraries closed except to staff and that overcrowding in the library of the National Collection of Fine Arts urgently needs to be relieved.

* Smithsonian Institution. Report of the Secretary and Financial Report of the Executive Committee of the Board of Regents for the Year ended June 30, 1954. (Smithsonian Publication 4182.) Pp. ix+175+4 plates. (Washington, D.C.: Government Printing Office, 1955.)

VISCOSITY OF POLYMER SOLUTIONS

AS a continuation of two earlier seminars on polymer science (see *Nature*, **171**, 65 (1953), and **172**, 102 (1953)), four lectures on the viscosity of polymer solutions were given in the Chemistry Department of University College, London, on March 11. Short abstracts of the lectures were circulated in advance, and this facilitated the discussions which followed the lectures. Prof. P. J. Flory dealt with relationships between the volume taken up by a flexible chain-like polymer and the viscosity of solutions containing such species. In good solvents the polymer molecules expand, and in poorer ones they assume a more nearly statistically unperturbed configuration. Through the use of suitable viscosity measurements, it is possible to

establish the unperturbed dimensions of the polymer chain, which depend on bond-lengths and -angles and on hindrance to free rotation. The theory, developed by Flory, enables, furthermore, an estimation to be made of thermodynamic parameters related to the heat and entropy of dilution of the polymer in a given solvent. It is also possible to explain the marked alteration of the viscosity of polyelectrolyte solutions brought about by changes of *p*H or ionic strength.

Prof. C. E. H. Bawn discussed intrinsic viscosity relationships for poly*iso*butylene and polystyrene in mixed solvents, some of the intrinsic viscosities being determined over a range of temperatures. These results were used to examine existing theories of the viscosity of polymer solutions and, in particular, the relationships dealt with by Prof. Flory.

Prof. J. A. V. Butler gave an account of viscosity measurements of two polyelectrolyte solutions, these experiments being done at low concentrations and rates of shear. Some of the results were interpreted with the help of an electrostatic theory of charged thread-like particles. Dr. B. A. Toms described a rheological investigation of about 3 per cent solutions of polymethylmethacrylate. The experiments were carried out with the help of a coaxial cylinder elastoviscometer. The rheological behaviour of these solutions can be specified by a viscosity coefficient, a relaxation time and a retardation time. The variability of these parameters indicates that relaxation of shear and of rate of strain are effected by different mechanisms.

THE COUNCIL FOR THE PROMOTION OF FIELD STUDIES

AFTER a stringent period of economy caused by financial difficulties, the chairman of the Council for the Promotion of Field Studies, Prof. S. W. Wooldridge, reports that the increased bookings at the field centres and the careful husbanding and disposal of the Council's resources have led to a happier situation and a development of the Council's activities: a grant for equipment has been made to each of the four centres, while the teaching staff of three of them has been augmented by the appointment of a field assistant. In addition, substantial capital expenditure to improve comfort and accommodation has been approved at Dale Fort and Juniper Hall. The fourth annual report of the Council also describes the work at the field centres in 1954*.

At Dale Fort, marine biology again proved the greatest attraction at the centre, only geography with all its variations providing comparable numbers.

At Skokholm, work has been begun on the annual marking of puffin chicks, while many puffins were ringed to throw light on the movements, attainment of maturity, mortality and expectation of life of these birds.

Students again contributed to the long-term research projects at Flatford Mill; these included investigations into the distribution and feeding habits of flounders at the head of the estuary, and the study of the vegetational succession taking place on mud-banks forming at the lower edge of Sherbourne Brook.

At Juniper Hall, geographical subjects of all kinds were the main interest of 53 per cent of the total number of students, while biological studies of one kind or another accounted for 39 per cent of the attendance; courses for sixth-form students from grammar schools and public schools formed the most stable element in the centre's economy.

An interesting development at Malham Tarn was the arrangement of a special course for secondary modern school teachers; this was done in conjunction with the West Riding Local Education Authority.

The report also contains details of some of the specialized work that was carried out at different centres.

* Council for the Promotion of Field Studies. Annual Report, 1953–54. Pp. 60+8 plates. (London: Council for the Promotion of Field Studies, 1955.)

NEBULÆ AND STAR CLUSTERS

AT the meeting of the Royal Astronomical Society on February 12, 1954, at Burlington House, London, the presidential address (read by Prof. H. Dingle in the unavoidable absence of the president, Dr. J. Jackson) was delivered on the occasion of the award by the Society of its Gold Medal to Dr. Walter Baade, of the Mt. Wilson and Palomar Observatories, for his observational work on galactic and extra-galactic objects. The address, which has been published in full (*Mon. Not. Roy. Astro. Soc.*, **114**, 3 (1954); and also *The Observatory*, **74**, No. 879 (April 1954)), commenced with a brief outline of Baade's work with the reflector of 1 m. aperture at Hamburg Observatory from 1919 until 1931, when he joined the staff of the Mt. Wilson Observatory to work with Hubble on the branch which was his chief interest at Hamburg—the direct photography and photometry of nebulæ and star clusters. Soon after his arrival at Mt. Wilson Observatory he undertook an investigation for determining the distance of the wispy cloud in Cygnus, a region to which he had given special attention when he was at Hamburg and in which he had found that many of the variable stars were eclipsing variables. Three classes of stars were used from Mt. Wilson observations for determining the distance—the eclipsing variables; long-period variables; and early *B*-type stars—and they indicated distance moduli of 12·5, 13·0 and 12·7, respectively, the latter being adopted. The question of the absorption of light in space then arose, and from the colour indices of eighty stars of type *B*8 to *A*5 a colour excess of 0·25 was found. On the assumption that this was due to pure Rayleigh scattering, Baade deduced that the Cygnus cloud was 2,630 parsecs distant; if no correction for absorption had been applied, a distance of 3,500 parsecs would follow from the adopted modulus. The few Cepheid variables found in the cloud gave very unsatisfactory results: four of long period were so faint that they could not be fitted in with the adopted modulus; two could be explained by heavy absorption; and two others might be much farther off than the cloud. In addition, five short-period cluster-type variables could not be fitted into the general result, but it was possible to explain them as belonging to the general galactic field of such objects.

The address next turned to another branch of Baade's work—that connected with novæ and supernovæ. The discovery by Ritchey in 1917 of a nova

in the spiral nebula N.G.C. 6946 was followed by the discovery of many other novæ in other extragalactic systems, and these discoveries opened up a new way for the determination of the distances of these systems if an absolute magnitude could be attributed to them. The results of the first efforts at this determination proved disappointing because of the very large range of magnitudes in the luminosities of the novæ observed. This unusually large range—up to eleven magnitudes—indicated one of two things: either there was a very large dispersion in the absolute magnitudes of the novæ; or there existed two groups of novæ differing in luminosity by a factor of the order ten thousand. The second alternative was shown to be the correct one as a result of Hubble's investigations of the Andromeda nebula, and Baade concluded that, in addition to the class of fainter novæ, to which most of our galactic novæ belong, there was also a class of supernovæ the average magnitude of which was about ten magnitudes brighter and hence they were visible in nebulæ so distant that the fainter novæ could not be observed there. The spectra of six supernovæ which were quite distinct from those of other stars, including ordinary novæ, obtained about the time of Baade's deductions confirmed Baade's views, which are now universally accepted. Dr. Jackson's address then went on to discuss fully the developments in this branch.

Turning now to other features in Baade's work, about a century ago Prof. G. P. Bond, in reporting on the rapid progress in photography, announced that stars to the sixth magnitude could be photographed; he then made the optimistic forecast that on some lofty mountain and in a purer atmosphere stars up to eighth magnitude might be photographed, and, by increasing the aperture threefold, all the stars up to the tenth and eleventh magnitude could be photographed. Bond lived long enough to see the aperture increase from 15 to 45 in. with a corresponding increase of about 2½ magnitudes in the stars that could be photographed. Dr. Jackson points out that there are other methods for increasing the photographic powers of telescopes, such as changing from a long-focus refractor to a short-focus reflector (which happened when he was at Greenwich) and improvement in clockwork and engineering; but unfortunately the stage is approaching in which fogging due to the light of the night sky is of the same order of intensity as that of the images formed by the faintest stars. The hope for the future lies with the sensitive plates, and at the meeting of the International Astronomical Union in Stockholm in 1938, Baade showed photographs of obscured regions of the sky taken with a new brand of red-sensitive plate. He stated that one plate showed eight hundred thousand stars to the square degree and that, with the optical means available, the limit had not yet been reached. It was a great triumph in 1942 when plates of the Andromeda nebula, taken with the 100-in. reflector, revealed for the first time "signs of incipient resolution in the hitherto apparently amorphous central region—signs which left no doubt that a comparatively small additional gain in limiting magnitude, of perhaps 0·3 to 0·5 mag., would bring out the brightest stars in large numbers". After this it was merely a matter of time for further investigations before successful plates were secured for about the restricted range of wave-length used, 6300–6700 A., so that the most troublesome part of the night sky was cut out.

Dr. Jackson's address dealt at length with the results obtained with these red-sensitive plates, and the following is a summary of Baade's view regarding Population i and Population ii in different regions of space (see *Astrophys. J.*, Sept. 1944). The method was applied to *M* 31 and the two companion nebulæ *M* 32 and N.G.C. 205, and, following their resolution into stars, Baade suggested that there are two types of stellar populations. Population i, in which bright giants and supergiant stars are common, is found in the arms of spiral galaxies but not in their central regions, and this population includes a higher proportion of binary stars but less novæ and supernovæ than Population ii. The latter includes no stars brighter than a normal giant, absolute magnitude about − 2, with comparatively low temperature, and also the high-velocity stars, stars found in globular clusters, in elliptical nebulæ and in the central unresolved regions of spiral nebulæ. In connexion with this subject, Baade's work on the Sagittarius cloud provides very interesting corroboration of the general view that our galaxy is a spiral nebula like the Andromeda nebula; if this resemblance is complete, the Sagittarius cloud, in the direction of which the centre of our galaxy lies, should contain stars of Population ii. Baade's investigations of this region with red-sensitive plates has shown that this is actually the case. Not only was the similarity to *M* 31 thus shown but also, allowing for a colour excess of 0·37 which involved a correction to the distance modulus of 2·6, the distance modulus was reduced to 14·7, indicating a distance of about 9 kiloparsecs. This is close to the generally accepted value for the distance to the centre of our galaxy, which is believed to be very similar in its contents to the Andromeda nebula —an intermediate spiral of type *Sb*.

At the end of Dr. Jackson's address, reference is made to the unsatisfactory position regarding determinations of very remote objects by the classical Cepheids and to the scheme which is being planned for settling the zero point. Direct trigonometric methods have supplied the distances of many stars of types *F* to *K* and, from these, reliable absolute magnitudes can be calculated. Baade hopes to observe such stars in the near future; but the work must necessarily occupy a long time as it involves not only accurate apparent magnitudes but also spectral classification or at least colour indices of very faint stars in clusters. In this scheme there lies great hope of deducing accurate absolute magnitudes not only of Cepheids but also of any other objects in the systems, and hence their distances. It is admitted, however, that the lack of transparency of space "remains a challenge but also a means of determining something about the contents of interstellar space".

JAPANESE FORESTRY RESEARCH

THREE Bulletins (Nos. 63, 64 and 65) of the Government Forest Experiment Station (Meguro-Ku, Tokyo, 1953) have been received. Nos. 63 and 65 deal with various research inquiries and studies dealing with forestry work. No. 64 is confined to research connected with studies on fog-prevention forests. Fog in Japan has a very serious effect both on agricultural and other operations in the Islands, and a study of the Bulletin is of considerable interest since it presents aspects of a danger which is little known elsewhere except as a nuisance.

In Report 3 of the Station, research work into "Forest Soils of Japan" is dealt with in a monograph. The forest soil survey was undertaken of the Kamo management unit. The area surveyed is situated on the slopes of the Amaji mountain range, Izu Peninsula. The grade of weathering of this area is higher and consequently the topography is more complicated than that of the Tagata management unit, which is on the opposite face of the mountain range. This latter had been the object of a forest soil survey for beech carried out by the research station in 1951 (Report No. 1). The elevations of the Kamo research area vary from 300 m. to 1,400 m.; consequently, the climatic variations are considerable, mild at the lower elevations and severe at the higher altitudes. Fogs frequently prevail on slopes above 800–900 m. Eighty per cent of the area surveyed are artificial forests of Sugi (*Cryptomeria japonica*), a species of tree which is well known as an exotic in several parts of the world—for example, it forms the chief tree in the Station of Darjiling in the Eastern Himalaya, where it was largely planted to replace the indigenous forest swept away while the Station was being built—and the remainder is occupied by the natural forest of *Fagus crenata* at the higher altitudes. The soils of this area belong to the brown forest soil group. There is a fine large soil map showing the distribution of these classified soils, which is more complicated than that of the Tagata area.

The Japanese Forestry Society has presumably re-commenced the publication of its *Journal*, the monthly numbers for August–November 1953 having been issued. The office of the Society is at the Government Forest Experiment Station, Meguro-Ku, Tokyo, where the *Journal* is published. A list of contents of each number is given on the back cover in English. The articles are confined to research investigations of various types which would be more suitable to the research publications of a research station than to a journal of a forestry society. But Japan is not alone in this, for several of the journals of European and other forestry societies follow the same tendency.

E. P. STEBBING

EFFECT OF IMPLANTATION SITE ON THE DEVELOPMENT OF AN IMPLANT IN THE CHICK EMBRYO

By DR. JOHN W. SAUNDERS, jun., and MARY T. GASSELING

Department of Biology, Marquette University, Milwaukee, Wisconsin

AND

DR. JOHN M. CAIRNS

Department of Anatomy, University of Oklahoma School of Medicine, Oklahoma City, Oklahoma

THE ability of leg mesoderm to control the course of regional differentiation of wing-bud ectoderm in the formation of feathers and other epidermal structures has been clearly demonstrated in the results of transplantation experiments combining leg mesoderm and wing ectoderm in the 3½–4-day chick embryo[1]. Ectoderm-free mesoderm from the proximal portion of the leg bud (prospective thigh), implanted in the proximal portion of the wing bud, induces the formation of ectodermal derivatives characteristic of the proximal part of the leg (that is, thigh feathers) in the wing ectoderm which grows over the implant. Similarly, mesoderm of the distal part of the leg bud (prospective foot), implanted distally in the wing bud, has brought about the formation of epidermal structures typical of the foot (scales, large claws). Thus the regional characteristics of the induced epidermal structures correspond not only to the leg source of the mesodermal implant, but also to the precise origin of the graft along the proximo-distal axis of the leg bud.

Since, however, the grafts were placed at proximo-distal levels of the wing bud corresponding to their levels of origin in the leg bud, these results do not disclose whether the proximo-distal level of the implantation site on the wing bud, or the source of mesoderm with respect to the proximo-distal axis of the leg bud, controls the regional character of leg structures formed from wing ectoderm associated with the graft. Accordingly, experiments were undertaken to examine the effect of implantation site on the regional differentiation of leg structures induced in wing ectoderm by an implant of leg mesoderm.

Isolates of mesoderm from the posterior proximal portion of the leg bud, the prospective material of the thigh region which forms the largest feathers of the leg, were grafted to the apex of the wing bud in embryos of stages 19 to 23 (3½–4-day embryos[2]) in the manner illustrated in Fig. 1. The mesodermal

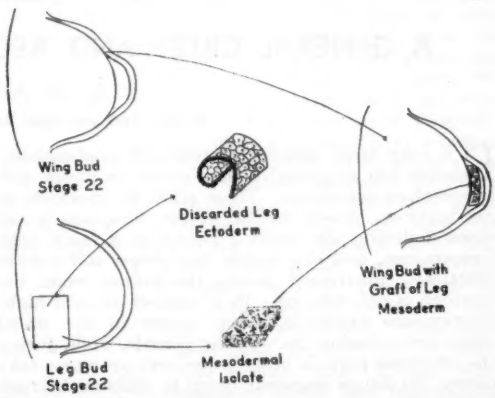

Fig. 1. Scheme of operation for combining prospective thigh mesoderm with ectoderm of the apical region of the wing. The graft becomes covered with ectoderm from the host wing bud soon after being implanted

Fig. 2. Terminal leg parts formed by the combination of prospective thigh mesoderm and ectoderm of the distal portion of the wing. A toe, bearing typical overlapping and warty scales and a large claw, is seen

implants averaged 0·135 mm.² in surface area and were approximately 0·1 mm. in thickness. The apical ectoderm of the wing bud was merely loosened from the adjoining ectoderm and mesoderm, then stretched slightly, to provide a site for the graft. With this procedure, the transplanted tissues developed in a terminal position on the wing.

Twenty-three embryos operated on in this manner survived to the fourteenth day of incubation or later. Of these, twelve showed no recognizable structures of leg type on the treated wing. The remaining eleven, however, showed large claws and/or scales, typical of terminal parts of the leg, in the region of the hand. In four of these cases, there appeared distinct toes complete with scales and claws (Fig. 2). In the other seven embryos, leg structures range from imperfectly formed toes to mere patches of warty scales on the hand region of a wing which appears relatively normal in other respects.

These results fully confirm the previous conclusion[1] that leg mesoderm implanted in the wing bud may induce epidermal derivatives of leg type in the associated wing ectoderm. Moreover, they clearly show that the regional characteristics of the induced leg structures are influenced by the proximo-distal level of the wing in which development of the graft takes place. Scales and claws have been induced by thigh mesoderm only when associated with the most apical regions of the developing wing. They have never appeared when grafts were made to the shoulder-level, or even as far distally as the wrist.

Finally, it should be noted that the environment of the wing-bud apex may modify the course of differentiation of the grafted thigh tissue itself. This seems rather evident, especially in those cases in which recognizable toes were formed. In such cases, the prospective thigh mesoderm presumably retained its quality of 'leg', but was modified in the proximo-distal character of its differentiation. In other cases specific effects of the wing environment are less clearly demonstrated. A number of grafts failed to form recognizable leg parts, and in some cases the hand was almost normal in appearance, although somewhat more massive than in the control wing. In these cases, the possibility is suggested, therefore, that modifying action of the apical wing environment brought about the formation of wing tissues from the grafted leg materials. While this interpretation may be open to some question, it seems clear that within the limb bud considerable portions of the mesoderm retain a certain developmental plasticity until late stages of development[3].

This investigation was supported by research grant *C*-1481 (*C*1, *C*2), from the National Cancer Institute, of the National Institutes of Health, Public Health Service; by a grant from the American Cancer Society, Milwaukee County Division; and by a grant from the Research Fund, University of Oklahoma School of Medicine, U.S.A. [Nov. 16

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A GENERAL CREEP AND RECOVERY PROPERTY OF METALS

By Dr. A. J. KENNEDY

British Iron and Steel Research Association, London

IN a very large number of practical applications, metals are subjected to discontinuous stress and temperature conditions. These arise, for example, in gas turbines, where certain of the components are stressed during the running period at a fairly high temperature, and afterwards cool down and remain practically unstressed during the period when the machine is not running. In a number of such high-temperature machines, creep occurs in the metal components during the working periods, while during the off-stress periods other (recovery) processes take place. So far as transient creep is concerned, creep deformation increases the resistance to further creep, while the recovery process reduces this resistance; thus the behaviour of any particular component depends upon the whole of its previous history. In general, the problem is extremely difficult to treat analytically, although certain useful approximations can be made, particularly when the stress cycles are fairly regular.

One general question which arises from these considerations is whether the best material for use under continuous creep conditions is also the best under the discontinuous conditions encountered in practice. Is it possible, for example, that a material which is resistant to creep may soften by recovery much more than some other material which is less resistant to creep under continuous stress conditions? The interaction of the fatigue process with such deformation and recovery mechanisms may also be important. These general questions cannot at present be answered with any certainty, but certain work on the transient

creep behaviour of a number of metals under various stress and temperature conditions has been completed and reveals a common property which is of importance in design. In order to present these results, it is necessary to make use of a mathematical treatment which has been proposed previously[1].

If a metal, under a particular set of conditions, exhibits a transient creep function of the form $\varepsilon = \beta t^p$, where β and p are constants (and p a fraction), ε the strain and t the time of creep, then, if the stress is interrupted after some time τ for a period ρ and then reapplied, a small new transient appears. It is convenient to express the form of the new curve by introducing the concept that a fraction n of the metal has wholly recovered. It has been shown that, for an isothermal interruption test, n satisfies a relation of the form:

$$(1 - n)/n = A(\tau/\rho)^p \qquad (1)$$

It was natural to assume that A would vary from metal to metal, even though p might be largely constant (it is usually near the Andrade value 0·3). In fact, for given values of τ and ρ, a number of metals, at different stresses and temperatures (but for all of which $p = 0{\cdot}33$), provided n-values distributed about a mean in the way shown in the inset histogram in Fig. 1. The ordinate is the number of test results obtained, the abscissa being divided into bands 0·03 wide. The mean n-value obtained provides (by the use of equation (1)) a value for A of about 9·0. This compares with values of 15 and 8 obtained in other experiments[1,2], and considering A may (in principle) take any value from zero to infinity, this is a good agreement.

A does, however, vary with p, as shown in Fig. 1. All the points could not be plotted for the case $p = 0{\cdot}33$, and only their range is shown. The continuous curve drawn is the rectangular hyperbola $Ap = 3{\cdot}0$. Substituting for A in equation (1), we find there are now no arbitrary constants.

We consider how such a result may arise. The magnitude of the initial transient has already been denoted by β; let the transient on reloading be α. Thus (essentially) $\alpha/\beta = n$.

A dependence of transient creep on temperature of the form:

$$\varepsilon = \psi[t \exp - (Q_c/RT)] \qquad (2)$$

where ψ is some function, has support from Mott[3] and from Dorn[4], and is certainly widely applicable.

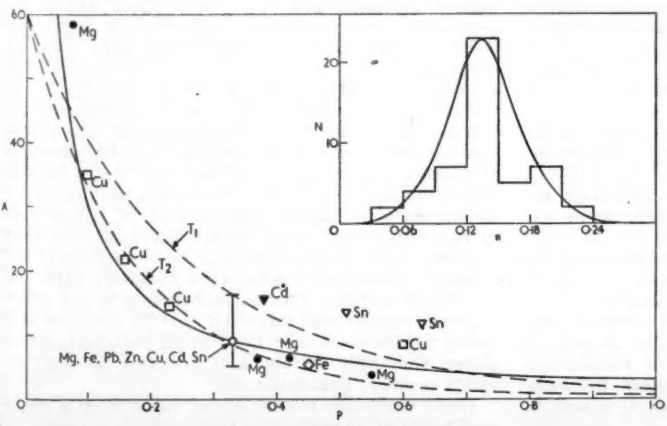

Fig. 1

Q_c is the activation energy for transient creep and T the absolute temperature. R is the gas constant. Using the transient creep function βt^p, β can be rewritten as the temperature-dependent quantity $\beta_0 \exp(-pQ_c/RT)$. So far as α is concerned, we wish to establish how this quantity varies with the recovery temperature for a fixed pre-history (fixed τ, ρ, creep stress and temperature), knowing that for a wholly isothermal interruption-test α/β varies very little with temperature. Noting the similar time functions which govern creep and recovery, we suggest a dependence of the form:

$$f(\alpha) = f(\alpha_0) \exp(-pQ_R/RT) \qquad (3)$$

Thus the conditions are satisfied if $f(\alpha)/\beta$ is a function of n only and if $Q_c \sim Q_R$. In particular, taking $f(\alpha) = \alpha/(\beta - \alpha)$, we derive $n/(1-n)$ as the relevant n-function in accordance with (1). Experiments can be designed to verify (2) and (3) and to determine Q_c and Q_R independently; for pure lead, we obtain $Q_c = 18{,}400$ and $Q_R = 19{,}800$ cal./mole. This is a satisfactory confirmation of their near-equality, but it does not solve the dependence of A on p. If $Q_R \sim Q_c = \Delta Q$, a small quantity, then n (for fixed p) is slightly dependent on temperature, though it may be masked by experimental scatter; n will also be slightly dependent on p, and the results will now lie along curves of the nature shown by the broken lines in Fig. 1. Taking $T_1 = 300°$ K. and $T_2 = 200°$ K., these curves would arise if $Q_c - Q_R = 2{,}400$ cal./mole. The actual values obtained above, for which $Q_R > Q_c$, would give an opposite trend. It is not possible to distinguish at present whether the general form of Fig. 1 arises in this way or not, simply because of the accuracy demanded in the determination of Q_c and Q_R, and also because ΔQ will certainly vary from metal to metal. The important general point is that Q_c and Q_R appear to be very nearly the same for all metals, suggesting that the two processes are controlled by the same basic mechanism.

Apart from their fundamental interest, these results have a practical application, as they show that the relative transient creep behaviour of materials under intermittent (on–off), as compared with continuous, stress under the same conditions is broadly a constant and does not vary significantly from one material to another, nor is it markedly dependent on the conditions of stress or temperature imposed, provided the type of creep curve exhibited (the value of p) remains the same. We are therefore led back to what might now appear to be a truism: the most successful creep-resistant materials (under continuous stress at a constant temperature) should also be the most successful under intermittent (but isothermal) conditions. It remains true that such intermittent conditions may possibly be more serious, so far as creep failure is concerned, than the continuous ones. These tests have been carried out on fairly pure metals, and although wide ranges of stress and temperature have been used, it is possible that certain more complex materials, such as creep-resistant alloys,

under more extreme conditions, may fail to behave in this way. In particular, the influence of temperature cycles remains an important problem. Certainly under these conditions it remains possible that the best material for any particular application may not be that which is most successful under isothermal continuous-stress conditions. Much more experiment is required before this consideration can be dealt with adequately. In any event, materials which exhibit structural transformations (such as recrystallization) under the test conditions will certainly not behave simply in accordance with the foregoing. Some progress has been made in handling these additional complications.

This work, which will be published more fully elsewhere, formed part of a research programme carried out at the Royal Institution under the Royal Society Armourers and Brasiers' Fellowship. Grateful acknowledgment is made to all these bodies for their support. [Nov. 30

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INHIBITION BY SIMPLE SUGARS OF ENZYMES WHICH DECOMPOSE THE BLOOD-GROUP SUBSTANCES

By Dr. WINIFRED M. WATKINS* and Prof. W. T. J. MORGAN, F.R.S.

Lister Institute of Preventive Medicine, London, S.W.1

WHILE studying the action of an enzyme preparation from the protozoan flagellate *Trichomonas foetus*[1] on the blood-group receptor sites on the human erythrocyte surface, it was found that the inactivation of the *H* specific structures could be inhibited by L-fucose and D-galactosamine[2]. This finding was of particular interest, because these sugars are components of the water-soluble *H* specific mucoid. The other two sugars contained in the carbohydrate portion of the *H*-mucoid, D-galactose and D-glucosamine, and a number of unrelated sugars, failed to inhibit appreciably the action of the enzyme. Furthermore, this observation enabled a differentiation to be made between the enzyme which inactivated the *H* receptors and that contained in the preparation which destroyed the blood-group *M* specific structures.

Many enzymes are inhibited by the products of their own activity; in the carbohydrate field this was early observed by Henri[3], who found that the action of invertase on sucrose could be inhibited by the addition of large quantities of invert sugar. Armstrong and Armstrong[4] afterwards showed that both glucose and fructose caused inhibition in this system, and also that maltase could be inhibited by glucose and methyl glucoside and lactase by galactose and methyl galactoside; a number of other sugars were without inhibitory power. More recently, Reese, Gilligan and Norkrans[5], in studies on the action of cellulase on cellulose preparations, have found that the reaction product cellobiose inhibits the enzymic hydrolysis. As it appeared possible from our preliminary experiments that the enzyme present in *T. foetus* which destroyed *H* specificity was inhibited by sugars which were the products of its own activity, a more thorough examination of the inhibition by simple sugars of the enzymes which decompose the blood-group substances was undertaken.

The partially purified enzyme preparation used for the studies on red cells was without action on the *A* and *B* specific structures, but crude extracts of *T. foetus* contain enzymes which rapidly destroy the serological activity of the water-soluble *A* and *B* mucoids. The inhibiting action of a number of simple sugars on (*a*) the enzymes present in crude extracts of *T. foetus* which destroy the *A*, *B* and *H* substances; (*b*) a partially purified preparation from *T. foetus* which destroys *H* activity only; and (*c*) a partially purified preparation from *Cl. welchii* (Type *B*) containing *A*- and *H*-destroying enzymes[6] was therefore examined. Purified water-soluble *A*, *B* and *H* substances[7], at a final concentration of 0·03 per cent, were used as substrates, and the percentage of the substrate inactivated by the enzyme, alone and in the presence of the sugars, was measured by means of the serological inhibition test[8]. The final concentration of the added sugar in each test was 0·66 per cent. Some of the results obtained using the *T. foetus* enzyme preparations are summarized in Table 1. The limitations of the serological inhibition test do not enable one to distinguish accurately between 50 and 100 per cent of unchanged substrate remaining after enzyme activity. In addition to the substances listed in Table 1, the following sugars, which did not give inhibition in any of the tests, were included for each enzyme: D-glucose, D- and L-arabinose, D- and L-xylose, D-ribose, L-sorbose, L-rhamnose, D-fructose, raffinose and cellobiose.

It will be seen from Table 1 that destruction of the *A* substance by the *T. foetus* enzyme was inhibited almost completely by N-acetyl galactosamine and its methyl glycoside and to a very slight extent by D-galactose, but not by any of the other sugars included in the test. Identical results were obtained using the enzyme from *Cl. welchii*. Destruction of *B* substance, by the *T. foetus* enzyme, on the other hand, was inhibited only slightly by N-acetyl galactosamine; but the same concentration of D-galactose, the α- and β-methyl galactopyranosides and certain disaccharides containing D-galactose, inhibited the action of the enzyme almost completely. The results obtained with the partially purified *H* enzyme from *T. foetus* were in agreement with those found previously in that L-fucose and D-galactosamine were strongly inhibitory; identical results were obtained with the *Cl. welchii* enzyme. The enzyme present in the crude *T. foetus* extract was inhibited only by L-fucose and not by D-galactosamine; but further examination has shown that this extract also contains an enzyme which destroys galactosamine.

These inhibition results are of value from a practical point of view because they provide a means of

* Beit Memorial Research Fellow.

Table 1. PERCENTAGE SUBSTRATE REMAINING UNCHANGED WHEN THE *T. foetus* ENZYME ACTS ON THE BLOOD-GROUP SUBSTANCES IN THE PRESENCE OF SUGARS

Sugar added	Unchanged substrate (per cent)			
	A-substance	*B*-substance	*H*-substance	
			Crude enzyme	Purified enzyme
Control (no sugar added)	3	1	1	1
L-Fucose	3	1	25	50–100
D-Fucose	3	1	—	1
L-Galactose	—	1	—	3
D-Galactose	6	50–100	1	1
N-Acetyl D-glucosamine	1	1	—	1
N-Acetyl D-galactosamine	50–100	6	—	1
D-Glucosamine	3	1	1	1
D-Galactosamine	3	6	1	50–100
α-Methyl L-fucopyranoside	3	1	—	3
β-Methyl L-fucopyranoside	—	—	—	1
α-Methyl L-fucofuranoside	3	1	—	1
β-Methyl L-fucofuranoside	3	1	—	1
α-Methyl D-galactopyranoside	3	50–100	—	1
β-Methyl D-galactopyranoside	3	50–100	—	1
β-Methyl D-galactofuranoside	—	3	—	1
Lactose	—	50–100	—	1
Melibiose	—	50–100	—	1
Methyl N-acetyl galactosaminide	50–100	—	—	—

differentially inhibiting the blood-group enzymes present in a crude mixed preparation; they are also of theoretical importance. The mechanism by which the blood-group-destroying enzymes break down the specific mucoids is unknown, as the specificity of the enzymes which brings this about has not been determined and the detailed structures of the groupings in the blood-group substances responsible for their serological activity have yet to be elucidated. Examination of the products liberated from the specific substances by enzymes from different sources[8] has shown that extensive breakdown of the molecule frequently occurs with liberation of all the component sugars. The enzyme preparations used, however, probably contain many carbohydrate-splitting enzymes, some of which may cause further breakdown of the molecule after the first enzymic change—that is responsible for the loss of serological activity—has taken place. The enzymes inhibited by the sugars must, however, be those which produce this initial change, and therefore an examination of these inhibition reactions enables a tentative conclusion to be drawn as to the nature of the enzymes involved in the destruction of the serological activity of the three blood-group substances.

The *A*, *B* and *H* substances each contain L-fucose, D-galactose, N-acetyl D-glucosamine and N-acetyl D-galactosamine; it is one of these sugars in each instance which inhibits the action of the corresponding enzyme. In view of the difficulty of measuring small changes in the concentration of the substrate, it has not been possible to carry out kinetic studies on these enzyme-inhibition reactions and thus to obtain evidence in support of the competitive nature of the inhibition. If, however, it is assumed that the enzymes are inhibited by their reaction products, it would appear that the initial change leading to loss of *A* serological activity involves the hydrolysis of an N-acetyl galactosamine linkage. This evidence supports earlier indications of the importance of N-acetyl galactosamine for *A* serological activity which were obtained from agglutination-inhibition tests using plant-seed hæmagglutinins[10]. Since D-galactose and the galactose-containing glycosides and disaccharides alone inhibited specifically the destruction of *B* substance, the enzyme leading to loss of serological activity for this mucoid could be postulated as a galactosidase. Galactosidases from other sources have failed to inactivate the *B*-specific substance; but this fact does not disprove the identity of the enzyme in the *T. foetus* extract as a galactosidase because the specificity requirements, with respect to the nature and structure of the aglycon, of glycosidases from different sources may vary widely[11]. The inhibition by L-fucose of enzymes from both *T. foetus* and *Cl. welchii* which bring about the serological inactivation of *H* substance supports the serological findings which have pointed to the part played by this sugar in determining *H* specificity. Thus anti-*H* agglutinins present in eel serum and in plant-seed extracts can be inhibited by L-fucose[12]. It is of interest that the methyl fucopyranosides and furanosides fail to inhibit the inactivation of *H* substance by the enzyme, whereas the galactopyranosides inhibit the enzyme which destroys *B* substance. It has been shown, however, that the partially purified *H* enzyme from *T. foetus* is without action on the methyl fucosides, although the presence of a fucosidase in the enzyme preparation is suggested by the fact that fucose appears as one of the hydrolysis products when the enzyme is allowed to act on the *H* substance. The inhibition by D-galactosamine of the enzyme decomposing *H* substance is difficult to explain. It is believed that this hexosamine is present in the N-acetylated form in the *H* specific mucoid, and yet N-acetyl galactosamine is without inhibitory effect.

The results of these inhibition experiments demonstrate that the enzymic hydrolysis of each blood-group substance is inhibited by a different sugar component. Presumably, therefore, a different enzyme is involved in the decomposition of each material; and it seems probable that the sugars which bring about the inhibition observed are those which play an important part in the characteristic serological specificity of the blood-group substances. These tentative conclusions provide a basis for further studies, and it is believed that similar inhibition experiments with simple substances may yield information in other systems involving the action of enzymes of unknown specificity on complex biological materials. [Feb. 17

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LETTERS TO THE EDITORS

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Indication of a Magnetic Field of the Planet Venus

If Venus had a magnetic field, it would at inferior conjunctions influence the corpuscular streams from the sun to the earth. We should expect a variation, probably a decrease, of the corpuscular intensity, which could reflect itself in the international daily magnetic character figures.

The appearance of the corpuscular streams is rather irregular, and the magnetic character figures are a rather crude measure. Further, the magnetic disturbances on the earth are caused not only by the corpuscular but also by the solar ultra-violet or X-radiation.

In order to detect the influence of Venus, it is therefore necessary to use statistical material as extensive as possible and to look for systematic variations in the averages. The magnetic character figures C are available for each day from January 1884 up to December 1953 [1]. During this time there were forty-four inferior conjunctions of Venus. I have tabulated the character figures for the forty-four dates of this phenomenon and the fifty days before and after each date. From this table the totals were determined for each day from − 50 to + 50 from conjunction date for different groups of conjunctions.

The totals for C were plotted against days by the method of superposition. The points are rather scattered and in some cases the 27-day period of the solar rotation is clearly indicated. In order to avoid the influence of a recurrent maximum or minimum of solar activity in the interval around zero day (conjunction), each value of the C-totals was corrected for the average deviation of the values at the twenty-seventh day before and after. The application of this correction was confined to twenty-three days before and seventeen days after conjunction, to avoid the influence on distant parts of the curves of the peculiarities which are shown in the curves between ten days before and four days after conjunction.

Fig. 1, *curve* (*a*), *all conjunctions* (44 *in number*). The lower values at zero day and a few days before are not much more significant than those occurring at other times.

Curves (*b*) *and* (*c*), *sunspot number R greater than* 50 (19) *and R less than* 50 (25), *respectively*. The effect of corpuscular streams on magnetic activity will be more pronounced in years of small solar activity, since during greater activity the relative effect of ultra-violet radiation is increased. Therefore the conjunctions of Venus were divided into groups of years in which the sunspot numbers R are greater than and less than 50 respectively. A dip from some

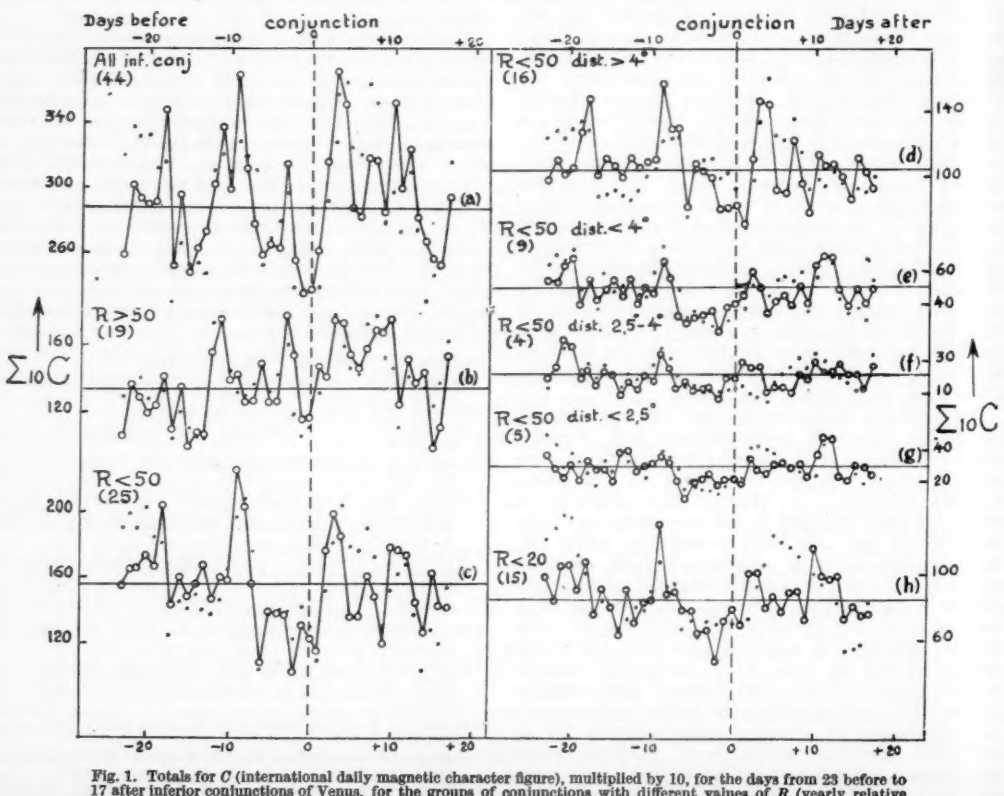

Fig. 1. Totals for C (international daily magnetic character figure), multiplied by 10, for the days from 23 before to 17 after inferior conjunctions of Venus, for the groups of conjunctions with different values of R (yearly relative sunspot number for the year of conjunction) and different angular distances between Venus and the sun at the moment of conjunction. ●, Direct plots; ○, corrected for the 27-day period of disturbances

days before until a few days after conjunction is fairly clearly indicated in the group with R less than 50.

Curves (*d*) *and* (*e*). Here we select the cases where R is less than 50 and the angular distances Sun–Venus are greater than and less than 4° respectively. Both groups show the dip already indicated by curve (*c*).

Curves (*f*) *and* (*g*). The subdivision of (*e*) into groups of angular distances at conjunction between 0°-2½° and 2½°–4° reveals that both groups show about the same decrease. Strong support of the reality of the effect is that the dip around zero day is common to all groups for R less than 50. A common maximum at nine days before, and perhaps one at two to three days after, conjunction is in some cases indicated. All other irregularities are different in type.

Curve (*h*). *R less than* 20 (15). This curve shows the closest analogy with curve (*e*).

The conclusion is that there is a marked decrease in the magnetic activity from seven days before to one day after conjunction. Comparing the curves for the selected groups and judging according to what we should expect, the presence of a real phenomenon is strongly suggested. Other details are still too uncertain to draw conclusions.

An estimation of the strength of the magnetic field of Venus starting from the observational material given above can only be a rough one, because of the complexity of the influence of a magnetic field on a stream of corpuscles, the properties of which are so little known. The asymmetry of the decrease around zero day suggests a deflexion of the corpuscular stream by Venus. If the magnetic axis of Venus should be orientated nearly perpendicularly to the plane of the orbit, then an electrically charged particle moving in, or nearly in, this plane would experience a force that would curve the path in the plane. In one of the two orientations of the magnetic field, the particle might be deflected in the direction opposite to the movement of Venus and the earth around the sun; in this case, before conjunction, the earth passes through a region of dispersion of the cloud; then, after conjunction, there will be a more concentrated stream to the earth. In any event, it would not be unexpected to find the minimum displaced from that for zero day. If the cloud was not deflected by Venus, but only the earth is shielded by Venus, the effect would be imperceptibly small; a minimum would occur on earth at a time after conjunction corresponding to the time needed by the corpuscular shadow that lags behind Venus to pass over the distance from conjunction to the earth.

At the moment of the beginning of the depression in the corpuscular intensity, seven days before conjunction, the earth will be in a region of the stream where the divergence has just become perceptible. We estimate rather arbitrarily that at that time the deflexion of the corpuscular rays reaching the earth may be of the order of 5° (α). In these circumstances it can easily be seen that particles with a velocity[2] of 500 km./sec. will have passed Venus at a distance $r_0 = 14 \times 10^6$ km. Assuming a dipole field around Venus, the expression for the magnetic field strength is $H(r_0) = \frac{mc}{2e} \cdot \frac{V_{\text{corp.}}}{r_0} \cdot \sin \alpha$. Substituting the values for protons with a velocity of 500 km./sec., we find, at $r_0 = 14 \times 10^6$ km., $H = 1{\cdot}5 \times 10^{-10}$ oersted. For the earth at the same distance, assuming again a dipole field, the field-strength is $0{\cdot}3 \times 10^{-10}$ oersted. As the problem is put here, the north–south orientation of the magnetic field of Venus is the same as that of the earth.

These considerations are, of course, much too simple to represent the real situation. In reality, the problem has essentially a three-dimensional character; for example, the magnetic fields to the north and south of the equatorial plane of Venus will play their part. Furthermore, the stream will consist of particles of different velocities and masses; and the stream will be electrically neutral, in which case the deflexion will be caused by the polarization of the moving streams in the magnetic field of Venus, and unless the densities are extremely small, a much stronger field will be necessary. This could be of importance for the explanation of the oblateness of the zodiacal gas cloud[3].

All these considerations direct the attention to the need for more theoretical work on this subject. As is clear from the complicated calculations on cosmic rays and the cause of magnetic storms and related problems, the task will not be an easy one. From the observational point of view, a detailed investigation of the magnetic variations during the weeks around conjunctions of Venus would be quite interesting; there seems to be here a unique opportunity of observing the influence of a planetary magnetic field on the corpuscular streams from the sun, not on the planet itself, which was hitherto the only possibility, but by studying the stream after its passage through such a field. A third attack on the problem must necessarily be the testing of the significance of the phenomenon by thorough statistical methods. Provisionally it seems that the observational evidence, if not conclusive, points in any event with fair probability towards the reality of the suspected relation.

I hope to investigate also whether there is a similar influence of Mercury; the moon will presumably be too close to show this phenomenon. However, in both cases the existence of a magnetic field is doubtful, since these bodies appear to have no liquid core.

J. Houtgast

Sterrenwacht "Sonnenborgh",
Utrecht.
Jan. 25.

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Photographic Preparation of Masks of Large Molecules for the Lipson Diffractometer

The optical diffractometer[1] developed by Lipson and others is being used in this laboratory for work on the structure of deoxyribose nucleic acid. This instrument has already proved its value, in work on structures of smaller molecules, as a rapid means of obtaining diffraction patterns due to trial structures, and it should clearly lend itself to application in the field of macromolecular structure in cases where enough is already known of the chemistry to enable trial structures to be produced. In the usual form, a projection of the trial structure is represented by

holes punched in an opaque mask, and the Fourier transform of this mask is obtained optically. A difficulty arises, however, in the application to large molecules, in that there is a minimum size of hole (about 0·5 mm. diameter) that can be punched in the mask. As a consequence, a large molecule can only be represented by covering a large area of the mask with holes. This gives a diffraction pattern on a very small scale, and it is found difficult to obtain the pattern without some distortion due to slight imperfections in the lens system.

It is therefore desirable that the mask should be produced on a smaller scale, and this means that the size of hole must be made still less. This can be done by photographic reduction; but the irregular variations in optical thickness of the glass plate and the gelatine coating will give rise to phase differences between the waves transmitted by the holes, which will alter the diffraction pattern. These differences can be partly avoided by sandwiching the plate between two optical flats and filling the spaces between the plate and the flats with cedar-wood oil, as was done by Bragg and Stokes[2] and H. Wyckoff (private communication); but this may not completely eliminate phase differences. A better method is to use a photographic technique in which the transparent parts of the gelatine in the photographic reduction of the mask can be dissolved away to leave clear holes. The present communication describes two methods of obtaining a mask using standard industrial photographic etching processes.

The required projection, for example, a few repeats of the unit cell content, is arranged as a number of positive transparencies on an evenly illuminated sheet of flashed opal glass. A photographic reduction of this series of units is then made directly on to Kodalith 'stripping film', which is processed by the method of 'etch bleach' reversal described in Kodak data sheet *PH*.5. It is found best to use a non-hardening fixing solution. The processed film is soaked in water at room temperature until the emulsion on its supporting membrane strips off readily. This membrane is laid emulsion downwards on the surface of an optical flat, excess water is gently squeezed off, and the membrane is allowed to dry. When thoroughly dry, the supporting membrane is dissolved away with acetone and the mask is ready for use in the diffractometer. The mask may be examined under the microscope for possible defects, such as error of hole size, incomplete removal of the stripping membrane, or uneven shrinkage.

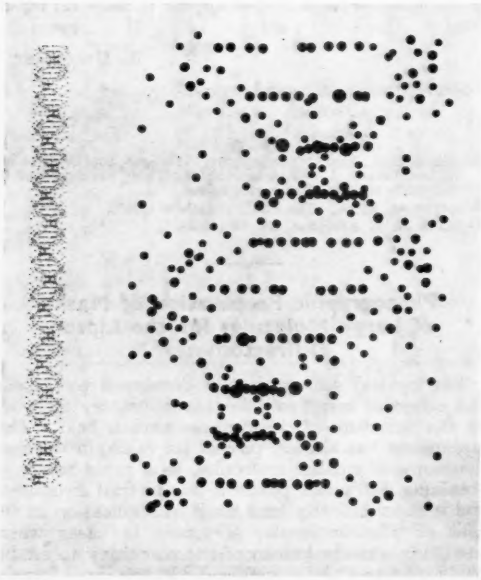

Fig. 1

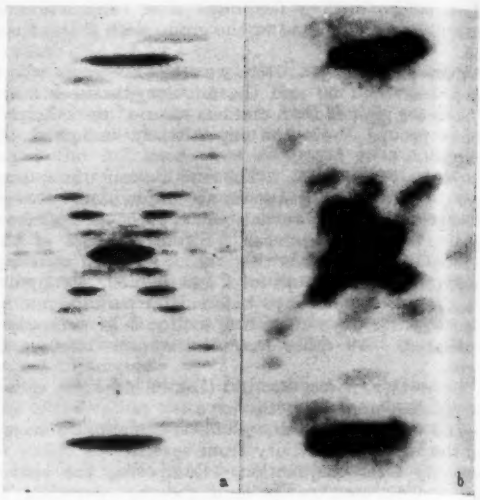

Fig. 2. Diffraction patterns from (*a*) photo-reduced mask, (*b*) punched mask

Using the method described, it is possible, with a reasonably good camera lens, to obtain a photographic reduction with a minimum size of hole of about 100μ over a circle of 5 cm. radius, and no difficulty is experienced in the processing. The method can be used for obtaining very much smaller holes ($\sim 30\mu$) in the emulsion, but the relative size of the holes varies greatly with exposure and processing, and a minimum hole of 100μ seems a reasonable compromise. No difficulty has been experienced due to shrinkage or distortion of the stripped emulsion membrane. The projection of one turn of the helical model of deoxyribose nucleic acid, together with the reduced mask, is shown in Fig. 1 (actual size). Fig. 2*a* shows the diffraction pattern given by this mask, and Fig. 2*b* the pattern given by the original punched mask for comparison. The poor quality of the second pattern, as compared with those usually obtained from punched masks of smaller structures, is, of course, due to the large linear dimensions of the mask and the consequent small dimensions of the diffraction pattern.

An alternative method of preparation of the reduced mask, in which the minimum size of hole may be very much smaller than 100μ, is by coating a silvered optical flat with a very thin layer of light-sensitive colloid, for example, bichromate gelatine. A negative is contact-printed on the colloid, and in those regions where there has been no exposure the colloid is dissolved away by the appropriate developer; the underlying silver is afterwards removed with an etching solution. To obtain the maximum resolution with this method the process requires very careful control.

We wish to thank Prof. J. T. Randall for encouragement and Dr. M. H. F. Wilkins for helpful discussion; Dr. G. W. W. Stevens, of Kodak, Ltd., and Mr.

F. Smith, of the London School of Printing, for advice on photographic methods. One of us (W. E. S.) wishes to acknowledge a grant from the British Empire Cancer Campaign.

C. W. Hooper

Medical Research Council
Biophysics Research Unit,
King's College, London, W.C.2.

W. E. Seeds
A. R. Stokes

Wheatstone Physics Laboratory,
King's College, London, W.C.2.

March 3.

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Doppler Spectrum of Sea Echo at 13·56 Mc./s.

The Doppler frequency shift of radio waves reflected from the sea surface at 13·56 Mc./s. has been recorded and a portion of a typical record is shown in Fig. 1. Such records show the following unexpected features: (*a*) the frequency of the principal component (as initially obtained by measurement of the length of individual cycles on the record) is surprisingly constant at about 0·38 c./s., irrespective of wind conditions and state of the sea; (*b*) the records show that the range of frequencies present is small. Spectrum analysis of the records made with an Admiralty wave analyser[1] confirmed these findings. Fig. 2 is a reproduction of a sample spectrum analysis which shows a large but narrow peak at a frequency of 0·38 c./s. accompanied by a smaller peak at a frequency of about 0·54 c./s.

A tentative explanation of these features can be offered if it is assumed that the sea waves act as diffraction gratings. It is known[2] that, under a given wind, sea waves of all lengths up to a maximum dependent on the wind velocity are generated. Of this multiplicity of waves, some travelling radially to the antenna will have a wave-length L and will reflect back a large signal when $L = \lambda/2$, λ being the radio wave-length. Since the velocity v of a sea wave of length L is given by $v = \sqrt{\frac{g}{2\pi}}\,L$, g being the acceleration due to gravity, then the Doppler shift Δf of this enhanced signal will be

$$\Delta = \frac{2v}{\lambda} = \frac{2}{\lambda}\sqrt{\frac{g}{2\pi}\cdot\frac{\lambda}{2}} = \sqrt{\frac{g}{\pi}\cdot\frac{1}{\lambda}}$$

In the present case, $\lambda = 22{\cdot}1$ m., $g = 9{\cdot}81$ m./sec.^{2}, gives $\Delta f = 0{\cdot}376$ c./s., agreeing closely with the value for $\Delta f = 0{\cdot}38$ c./s. found from Fig. 2.

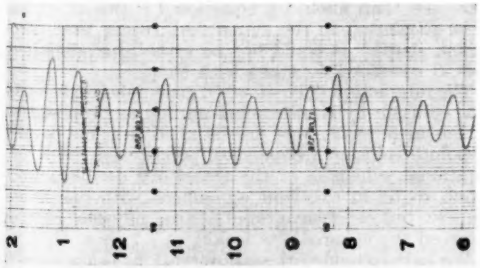

Fig. 1

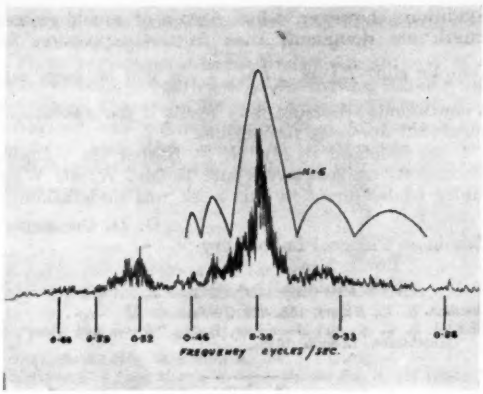

Fig. 2

It might also be expected that components of non-sinusoidal waves of wave-length $L = n\lambda/2$, n being an integer, travelling radially towards the antenna, would cause reinforcement and thus large reflected signals. These would then have Doppler shifts $\Delta f = \sqrt{\frac{g}{\pi}\frac{n}{\lambda}}$. The subsidiary peak in Fig. 2 at a frequency of 0·54 c./s. $\approx 0{\cdot}38\sqrt{2}$ thus suggests that this is due to waves having a length $L = \lambda$.

Both the peaks in Fig. 2 depart considerably from line spectra. At first sight this could be explained by considering that the relatively short waves of length $L \approx \lambda/2$ are superimposed on the crests of much longer waves and thus have velocities dependent on the lengths and heights of the larger waves. However, this would lead to a continuous spectrum, whereas in the neighbourhood of the larger peak in Fig. 2 there are small subsidiary maxima which on this argument would be unlikely to occur. An alternative explanation of the shape of the spectra is that the sea waves exist in short trains. The first-order ($n = 1$) diffraction patterns of short sea-wave gratings of variable spacing L have been calculated, and by the use of the relation $\Delta f = \frac{2}{\pi}\sqrt{\frac{g}{2\pi}\cdot L}$, may be drawn as Doppler shift spectra. Superimposed on Fig. 2 is such a spectrum obtained for a grating containing six wave crests. The agreement is considered to be good. This may be of interest to oceanographers, since the explanation does not completely conform with accepted ideas of the behaviour of sea waves.

The explanation above would suggest that by the use of radio waves of lower frequency longer sea waves would be observed, and that the use of an equipment of variable frequency would result in a sea-wave spectrometer. At very high frequencies under extremely calm conditions, however, when sea waves of length comparable with the radio wave-length are dominant, similar results to those found here at lower frequencies should be obtained.

It is interesting to note that, because capillary waves have a velocity which decreases with wave-length, then the Doppler shift for radio wave-lengths less than 4 cm. under very calm conditions should increase more rapidly with decreasing wave-length than at longer radio wave-lengths. Under normal

conditions, however, when waves of much greater length are dominant, then in the expression for Doppler shift $\Delta f = \sqrt{\frac{g}{\pi} \cdot \frac{n}{\lambda}}$, n will be large and a continuous spectrum may result if the mechanism suggested above is responsible.

I am indebted to Mr. N. F. Barber for valuable discussions on sea waves and to Mr. W. H. Ward under whose direction this work was undertaken.

D. D. Crombie

Dominion Physical Laboratory,
Lower Hutt,
New Zealand.

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Effects of Temperature and High-speed Sliding on the Friction of 'Teflon' on 'Teflon'

In a recent study in this laboratory of the frictional properties of 'Teflon' (polytetrafluoroethylene) two experimental results stand out: (1) the coefficient of friction at low sliding speeds is very low (0·05–0·08), as reported in the literature, only if the surfaces have not previously been subjected to high-speed sliding; (2) with rising temperature, there is a marked increase in the friction of 'Teflon' on 'Teflon' in the vicinity of 20° C., where a phase transition in 'Teflon' is known to occur.

The observation was made by causing a 'Teflon' rider to bear against a rotating 'Teflon' cylinder, the friction being measured by means of strain gauges attached to the flexible rider holder[1].

The first of the experimental results serves to illustrate the important effects which surface preparation and conditioning may have on friction. It has been found, for example, that clean, newly prepared surfaces in sliding contact at low speed (1·1 cm./sec.) exhibit low friction for at least 4,100 traversals over the same track. On the other hand, if the same surfaces are subjected to sliding at high speed (189 cm./sec.), the friction increases ($\mu_k = 0{\cdot}36$) and the condition of the track becomes irreversibly changed. Subsequent sliding at low speed is then accompanied by a two- to three-fold increase in the friction coefficient over the original low-speed value.

These observations do not contradict previous work in other laboratories on the friction of 'Teflon' on 'Teflon' but rather supplement it[1,2]. Previous workers have presumably used new surfaces and have measured either static coefficients or kinetic coefficients at sliding speeds of the order of 0·01 cm./sec. Bowers, Clinton and Zisman[3] studied the friction of steel rubbing on 'Teflon' and found that both μ_s and μ_k increased slightly after thirty passes (the steel rider being cleaned after each pass) and after a hundred passes μ_s had increased to 0·13 and μ_k to 0·08. To the best of our knowledge, there is no previous mention in the literature of the effect of continuous sliding on the friction of 'Teflon' on 'Teflon'.

The second result of particular importance is the relationship between friction and temperature for 'Teflon' on 'Teflon'. By varying the temperature of the cylinder within the range 12°–30° C., it has been found that a sharp increase in friction (about two-fold) takes place as the temperature is raised through 17° C. In view of the fact that the bulk temperature of the rider is above that of the cylinder, and that localized heating effects may also be present, there can be little doubt but that the rise in friction is related to the phase transition in 'Teflon' which takes place[4] at 20° C. This change in friction is reversible, as apart from the irreversible change produced by high-speed sliding.

A more complete discussion of these and other frictional properties of 'Teflon' will be published at a later date. It is important, for the present, to emphasize the close relationship between the frictional and structural changes which take place in this polymer.

One of us (D. G. F.) wishes to acknowledge helpful discussions with Dr. J. D. Hoffman, who first directed our attention to the phase transition at room temperature in 'Teflon'.

D. G. Flom
N. T. Porile*

General Electric Research Laboratory,
Schenectady, New York.
Dec. 29.

* Present address: Dept. of Chemistry, University of Chicago, Chicago, Illinois.

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Rotations, Orientations and Collisions of Suspended Particles in Velocity Gradients

Particles suspended in a liquid subjected to a velocity gradient undergo rotational and translational movements. For fluid velocities u, v, w, along the x-, y- and z-axes given by $u = Gy$, and $v,w = 0$, Jeffery[1] has shown that a prolate spheroid of axial ratio r, in the absence of Brownian motion and interaction with other particles, rotates with a period

$$T = 2\pi (r + 1/r)/G \qquad (1)$$

in a fixed spherical elliptical orbit described[2] by

$$\tan \lambda = Cr \sin 2\pi t/T \qquad (2)$$

where λ is the angle between the z-axis and the x-z projection of the main particle axis and C is the orbit constant. The particle, when viewed as its projection on the shear planes, should therefore appear to oscillate between $\pm \lambda_{max.} = \tan^{-1} Cr$.

Measurements[2] on single rods have shown excellent agreement with equation 2. Values of T, however, were less than given by equation 1; this effect has been attributed to the cylindrical, rather than ellipsoidal, shape. It could not be established definitely that C remained constant with time.

The interaction of equal-sized glass spheres, brought into collision by translational motion as proposed by v. Smoluchowski[3], was also studied in some detail[4]. Absolute collision frequencies, persistence times and rotational velocities of the transitory doublets were found to be in excellent agreement with calculated values; but conclusive proof of true physical contact between the spheres was lacking.

We have extended these observations using various particles suspended in corn syrup of viscosity 50 p. at values of G up to 2·5 sec.$^{-1}$.

It has now been established that, in the absence of interaction, a single straight rigid rod rotates in an orbit which remains constant over hundreds of successive particle rotations. This differs from earlier cursory observations by other workers[5], who report a drift to $\lambda_{max.} = 0$ or $\pi/2$.

The variation in rotational velocity of a rod at various positions in its orbit yields preferred orientations in various reference planes. Instantaneous distributions of λ, determined after shearing initially isotropic suspensions, yielded a steady-state distribution with a preferred orientation along $\lambda = \pi/2$, that is, in the direction of flow, after about 3,000 particle rotations. The orientation distribution functions can also be calculated from Jeffery's equations for single particles and the distribution function of C. Jeffery[1] assumed that at statistical equilibrium the viscosity tends to its minimum value, that is, $\lambda_{max.}$, $C = 0$ for all particles, while Eisenschitz[6] assumed that each particle retains its original orbit. We have found the actual distributions to lie between those calculated from the two sets of assumptions. To establish a steady state, each particle must undergo a change both in rotational phase and in C; these changes occur as a result of collision between orbits. The distribution of particle orbits, which determines among other things the viscosity of a suspension, is therefore governed by the mechanics of particle interaction.

In mixed suspensions of glass spheres of diameters a_1 and a_2, interactions vary with a_1/a_2. When $\frac{1}{4} < a_1/a_2 \ll 1$, collisions are well defined and similar to those of equal-sized spheres[4]. From the assumptions made previously[4], the number of collisions per unit time suffered by a type-1 with type-2 spheres is readily shown to be

$$f_{1,2} = \frac{1}{6}(a_1 + a_2)^3 n_2 G$$

where n_2 is the number concentration of type-2 spheres.

Direct measurements of more than 860 collisions in suspensions with $a_1 = 180\mu$ and $a_2 = 117\mu$ yielded $f_{obs.}/f_{calc.} = 1{\cdot}09$; this is within the estimated limits of error.

As a_1/a_2 is reduced below 0·5, the phenomena of interaction appear to change gradually. Instead of making apparent contact, a small sphere on approaching a large one executes either (i) planetary motion around the larger sphere for a definite number of revolutions, or (ii) an oscillating motion roughly parallel to the x-axis, and then separates. In both types of interaction, the spheres can be seen to be separated at all times. It is concluded from these observations that true physical contact does not occur during the life of doublets of equal-sized spheres.

Up to the highest shear-rates attainable, single air bubbles having diameters up to 200μ show no measurable distortion and rotate with the same angular velocities as rigid spheres, that is, $\omega = G/2$. This accords with Garner's observations that at low Reynolds numbers sedimenting fluid spheres behave as though solid[7]. Upon interaction, two bubbles of equal size form a doublet; but, instead of the mirror-image separation observed with neutral rigid spheres[4], the doublet continues for as many as fifty rotations, and then the pair suddenly coalesces into a single sphere. This suggests that, while the particles may not actually collide, they approach each other initially close enough to allow attractive forces associated with the surface to come into play and afterwards hold the spheres together.

These experiments were carried out as part of a study of the aggregation of paper-making fibres; but the results are also of interest in connexion with flow behaviour and particle aggregation in suspensions, colloidal sols and solutions of macromolecules. Experimental details and discussion will be published elsewhere.

R. St. J. Manley
A. P. Arlov
S. G. Mason

Pulp and Paper Research Institute of Canada,
Montreal, Quebec.
Aug. 18.

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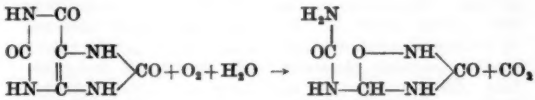
The Origin of Man

Although the Darwin–Mendel–De Vries theory of evolution provides a general frame for understanding the emergence of man, it leaves open crucial questions of detail. Why have man, and, to a lesser extent, the higher apes so strikingly exceeded other animals in intellectual development? Was it by the chance accumulation of a vast number of favourable mutations, each relatively insignificant? In other words, was their development like the cascading of the ball on Galton's board from peg to peg until it happens to fall into the outermost compartment at the bottom? Or can one recognize distinct turning-points of the development? A well-known fact of physiology, the possible evolutionary significance of which does not seem to have received attention, points strongly towards the second alternative.

Mammals are distinguished from other vertebrates and from insects by their ability to produce the enzyme uricase, which oxidizes uric acid to allantoin by breaking up its purine ring according to the scheme:



Uric acid — Allantoin

The only exceptions to this are man and the higher apes, which have lost the capacity for synthesizing uricase and which, therefore, end the metabolism and catabolism of nucleoproteins with uric acid, instead of carrying it on to allantoin. Until recently, the Dalmatian dog (coach-hound) was also thought to be an exception. However, it has been found[1] that this animal does possess sufficient amounts of uricase; it excretes uric acid merely because, owing to the effect of a simple recessive gene[2], no tubular re-absorption of uric acid from the glomerular filtrate takes place in its kidneys[3].

Uric acid has two remarkable properties. It is very sparingly soluble in water; meat-eating animals that lack uricase, therefore, have to maintain a steady

high concentration of uric acid in their blood in order to eliminate the amount they produce. Moreover, uric acid, in common with other purines such as caffeine or theobromine, is a cerebral stimulant. Consequently, animals that eat nucleoproteins but lack uricase are under constant influence of a powerful stimulant.

This circumstance may have played a decisive part in the intellectual development of the higher primates. The selective value of a small beneficial mutation of the associative mechanism of the brain must be very small, unless the animal uses its brain even when this is not urgently necessary; that is, unless it thinks about past experiences and future possibilities in times when there is no acute need for thinking. Such a tendency to philosophical reflexion must be very unusual in animals; even modern man has, in general, no irresistible addiction to mental work. A beneficial mutation of the associative mechanism of the brain, therefore, has only a poor chance of establishing itself in the species unless its selective value is strongly enhanced by the action of a cerebral stimulant such as is uric acid. The mutations that have led to the loss of uricase, then, may have been a crucial step on the way to the development of man.

In all probability the loss of uricase was not a sudden event due to a single mutation. Some monkeys seem to show a slightly impaired capacity for uricase production: this suggests a gradual assembly of the gene-constellation that has ultimately led to the almost complete absence of uricase. In the lower mammals, this assembly did not progress beyond a primitive stage, because the higher brain functions were relatively undeveloped, and the effects of their stimulation by uric acid could not counter-balance the physiological disadvantages of this compound. From a certain stage of the brain development onwards, however, the increment of viability due to uric acid must have changed its sign from negative to positive, and then the assembly of the uricase-loss gene constellation could progress hand in hand with the accelerated development of the brain due to the increasing level of uric acid concentration.

Can the viability-increment due to a stimulant be large enough to cause such momentous developments? Although quantitative indications are lacking, there is a strongly positive body of general experience. The triumph of will-power and 'drive' (that is, of certain internally secreted or otherwise produced stimulants) over innate talent was a popular theme of all literatures long before Æsop's tale of the hare and the tortoise. Millions of the present generation owe their careers, and some even their lives, to caffeine or theobromine, taken during preparation for an examination, a negotiation, or during a strenuous car-drive. Uric acid, of course, is not so effective as coffee or tea; but its effect as a catalyser of mental development has extended over a million years, starting probably long before the Oligocene branching of the great orthograde primates. A widespread popular opinion associates the vigour and initiative of the populations of the wealthy industrial areas with their high meat consumption. It is well known that a small fraction of this consumption would be sufficient for tissue regeneration; if the popular opinion has any solid foundation, therefore, a more likely reason for the effect of nucleoproteins is the high level of uric acid concentration in the blood. In fact, it is quite likely that the 'pressure-of-life' diseases prevalent in the highly industrialized areas are, to a considerable extent, 'pressure-of-uric acid' diseases. Although not so effective as caffeine or theobromine, this stimulant can be a more powerful inhibitor of rest and recovery from work by its action extending over day and night.

E. Orowan

Department of Mechanical Engineering,
Massachusetts Institute of Technology,
Cambridge, Mass.
Dec. 25.

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Variation in the Amounts of Deoxyribonucleic Acid in the Cell Nuclei and its Correlation with Mitotic Activity: Compensatory Hypertrophy of the Kidney

The deoxyribonucleic acid content of the interphasic nuclei is, for a given species, approximately the same in the different tissues and double that of the spermatic nuclei of the same species. However, it is known that certain organs contain different classes of nuclei with an amount of deoxyribonucleic acid that is a simple multiple of the basic value. This constancy of deoxyribonucleic acid content is considered by some to be absolute[1]; others claim on the contrary that the 'theoretical diploid value' is only an equilibrium value, from which the mean content varies more or less widely, as a function of the physiological[2] or mitotic activity[3] of the cells. The influence of mitotic activity upon the deoxyribonucleic acid content of the nuclei of the tubuli in a kidney showing compensatory hypertrophy after extirpation of the kidney on the other side has been studied by us.

The left kidney of five white rats was extirpated; the animals were killed, together with five controls, seven days after intervention. Nephrectomized animals and controls received 9 hr. before death an injection of colchicine (0·2 mgm./100 gm. total weight) in order to block the mitoses in metaphase. The right kidneys of the different animals were utilized in our work. They were fixed in a mixture of alcohol 96° (75 parts), formol 40° (20 parts) and acetic acid (5 parts); a testicle of a control rat was also fixed. All the dehydration operations and embedding were performed simultaneously. The sections (10 microns) were placed on the same slide and treated by the Feulgen reaction. The intensity of the mitotic activity was determined approximately by counting the stathmocineses per 1,000 nuclei in the tubuli contorti I. For the nephrectomized rats about 5 per thousand mitoses were found. In the controls the mitotic activity was very low indeed: examination of the whole section showed only one or two mitoses. The increased mitotic activity is correlated with compensatory hypertrophy (about 30 per cent in weight).

The relative deoxyribonucleic acid content of the individual nuclei was measured *in situ* on the Feulgen-stained preparations with Lison's histophotometer[4]. In every kidney a hundred interphasic nuclei were measured; in order to determine the theoretical diploid value, a hundred nuclei of spermatocytes I were also measured.

The mean values of the five controls are statistically very constant and obviously less than the theoretical diploid value (mean deoxyribonucleic acid content of spermatocyte I /2 = 980·1 ± 7·98). The mean values of the nephrectomized rats show a clear tendency to increase, without reaching the theoretical diploid value. In order to demonstrate objectively this impression we pooled the measurements in each group.

Pooled results	n	$\bar{x} \pm S\bar{x}$	S
Nephrectomized	500	900·5 ± 5·0	111·9
Controls	500	842·5 ± 4·4	98·5

t-test	t	p
Controls/nephrectomized	8·78	<0·001

By Student's test it is demonstrated that the increase of deoxyribonucleic acid after nephrectomy is highly significant. We therefore conclude that the increase of the mitotic activity produced in the tubuli contorti of the kidney by compensatory hypertrophy after contralateral nephrectomy is correlated with an increase of the deoxyribonucleic acid content of the interphasic nuclei.

This investigation was aided by a grant from the Belgian National Foundation for Scientific Research.

J. Fautrez
G. Cavalli
E. Pisi

Department of Human Anatomy,
and
Belgian Centre of Normal and
Pathological Growth,
University of Ghent.
Dec. 14.

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Synthesis of Peptides by Aminolysis of Nitrophenyl Esters

The aminolysis of esters has already played a part in early attempts at peptide synthesis, as in the works of E. Fischer[1]. Fischer recognized that methyl esters react more readily than ethyl esters. Recently, H. Brockmann and H. Musso[2] applied methyl esters of amino-acids to the preparation of peptides. The more reactive esters were not used, though the work of M. Gordon, J. G. Miller and A. R. Day[3] shows that the speed of aminolysis of vinyl, and especially phenyl, esters of fatty acids is several magnitudes greater than that of the ethyl or methyl esters.

We have investigated the action of the phenyl ester of a protected amino-acid (the phenyl ester of phthalylglycine) on the ethyl ester of glycine, and found that in benzene solution at room temperature, after some days, the ethyl ester of phthalyldiglycine could be isolated in good yield. Th. Wieland and co-workers[4] used the thiophenyl esters for the same purpose, their view being that the thio-acids, which readily form amides, should be employed in this case. They used thiophenyl esters only, because they were not able to synthesize the amino-thio-acids at that time. In his more recent work, Th. Wieland reports results obtained with thio-acids since prepared by him.

We believe that Wieland in this work with thiophenyl esters is perhaps not quite correct in emphasizing their character as thio-acid derivatives. We think rather that their reactivity is due to the fact that they are phenyl esters. In recent experiments, we have examined the esters of nitrophenols, which contain a phenolic hydroxyl group with a hydrogen of greater degree of dissociation, and it was found that the speed of aminolysis of the nitrophenyl esters is much greater than that of the phenyl ester and even than that of the thiophenyl ester. Table 1 shows the relative reactivities of the phthalylglycine esters at the boiling point of benzene.

Table 1

Phthalylglycine ester	Per cent transformation in 20 min.	Phthalyldiglycine isolated (per cent of theoretical)
Phenyl ester m.p. 123–124° C.	26·5	2·6
Thiophenyl ester m.p. 103–104° C.	47·5	30·8
o-Nitrophenyl ester m.p. 169–171° C.	90·0	76·0
m-Nitrophenyl ester m.p. 160–161° C.	97·5	82·7
p-Nitrophenyl ester m.p. 180–181° C.	95·0	75·2

The dinitrophenyl ester of phthalylglycine (m.p. 217° C.) in dioxane solution and ethylglycinate react rapidly with evolution of heat.

In our opinion the phenyl esters, especially the nitrophenyl esters, deserve further attention. They are less reactive than the acid chlorides, the acid azides or the mixed anhydrides; but that is often an advantage. For example, if there are free hydroxyl and amino groups simultaneously present (tyrosine, serine), it seems desirable to prepare first the well-defined nitrophenyl esters and then proceed to the selective acylation of the NH_2 group. Harington and Pitt Rivers[5], in their synthesis of S-benzyl-N-carbobenzyloxy-cysteinyl tyrosine, first protect the hydroxyl group of tyrosine and then add to it the protected cysteine by Curtius's method. Thus the synthesis required ten steps, in place of which the same protected peptide could be obtained more simply and in good yield through the reaction of S-benzyl-N-carbobenzyloxy-cysteine-*p*-nitrophenyl ester (m.p. 84° C.) with ethyl tyrosinate, followed by saponification of the ethyl ester group.

M. Bodánszky

Research Institute of the
Pharmaceutical Industry,
Budapest.
Nov. 29.

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Identification of the Protein Fraction of Human Serum containing the Thyrotropic Hormone

After paper electrophoresis at *p*H 8·6 in a veronal-sodium buffer of a purified bovine hypophysial thyrotropic hormone preparation, the hormonal activity was found to move with the same speed as the β-globulins of human serum under similar conditions. The thyrotropic hormone assay was carried out by the iodine-131 accumulation test in mice treated with iodocasein[1].

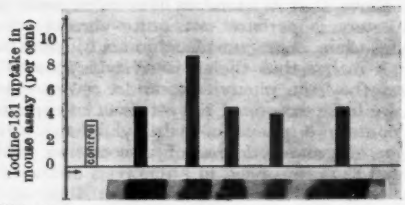

Fig. 1. Identification of thyrotropic hormone activity in human serum protein fractions obtained by paper electrophoretic separation

Cohn[2] has stated that the thyrotropic hormone activity in human serum is present in the β-globulin fraction. However, so far as we know, no evidence supporting this statement has yet been published. Therefore we decided to study the distribution of thyrotropic hormone in the various serum protein fractions more fully. Fractionation of the serum was carried out at − 5° C., using ethanol as precipitating agent, as described by Cohn *et al.*[3]. It was observed that in all cases in which thyrotropic hormone activity was demonstrable, it was present in the fraction IV-4, which contains, apart from some albumin, most β-globulin and α-globulin. Our results will be published in detail elsewhere.

Recently, we encountered a serum with an extremely high thyrotropic hormone content equal to about 12 mgm. U.S.P. arbitrary standard (= 120 Junkman–Schoeller units) in 100 ml. serum. This enabled us to identify by paper electrophoresis the fraction containing the active principle. Localization of the various protein fractions was carried out by staining with naphthalene black one of the strips. Other strips which had run simultaneously were cut up into corresponding pieces, and the thyrotropic hormone activity of the pooled fractions was determined after elution, dialysing and freeze-drying.

The results obtained are shown in Fig. 1. From them the conclusion seems to be justified that the thyrotropic hormone activity of human serum can only be demonstrated in the β-globulin fraction.

L. D. F. Lameijer
A. A. H. Kassenaar
A. Querido
Department of Clinical Endocrinology and Diseases of Metabolism,
University Hospital,
Leyden. Dec. 8.

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Adsorption as a Major Phenomenon in the Concentration of Gonadotrophins by Ultrafiltration

During a study undertaken to evaluate the ultrafiltration method for concentration of gonadotrophic hormones from urine[1], we investigated the role of adsorption in this procedure. It is well known that adsorption participates in ultrafiltration[2]. In his article Gorbman suggests the possible importance of adsorption in the method of isolation of gonadotrophic hormones. Grabar (personal communication, 1950) reported adsorption of urinary gonadotrophic hormones when urine was allowed to drip through a nitrocellulose column. No quantitative results, however, seem to have been reported in the literature so far.

The methods used for ultrafiltration and bioassay have been described elsewhere[3]. In general, the Gorbman ultrafiltration technique was used with some modifications, the main one being adjustment of urinary *p*H to 5, prior to ultrafiltration. The immature mouse uterine weight bioassay was used, following the method of Klinefelter *et al.*[4].

For interpretation of results, the average of the logarithms of uterine weights (in mgm.) of groups of mice (y) were used rather than the average weights in milligrams, thus permitting calculation of the standard error T_y between y's from different groups, this value being 0·119 when five mice per group were taken.

In shaking-experiments, collodion filters (diameter approximately 17 cm.), prepared as usual for ultrafiltration, were shaken with 500 ml. of postmenopausal urine collections, preserved in a cool place and the gonadotrophic hormone content of which was fairly well known. Urine was shaken at room-temperature (a cold room was not available) at a rate of approximately 120 per min. When shaking was completed, filters were processed as after ultrafiltration; for example, the collodion was dissolved in alcohol–ether, the precipitated and centrifuged residue containing gonadotrophic activity dried and the activity of extracts tested by bioassay. The remaining urine was ultrafiltered in order to determine the amount of gonadotrophic hormone left behind. In control experiments an identical aliquot of the same specimen of urine was processed by ultrafiltration only. Bioassays of extracts from the same urine specimen were carried out at the same time in order to avoid daily variations in uterine response that had been previously shown to be significant.

In preliminary studies urine was shaken with nitrocellulose; only minimal amounts of gonadotrophic hormone appeared to be adsorbed. When urine was shaken with one collodion filter for five minutes, no adsorption to the filter was demonstrated. However,

Table 1. Adsorption of Gonadotrophins to Collodion Filters Shaken with Urine

Exp.*		Shaking 1st hr.	Shaking 2nd hr.	Ultrafiltration filtrate after shaking	control urine
a	Coll. 1·2% Ph. 5·5	1 filter	1 filter		
	Level U†	400 200	96 12	10	400 200
	y‡	1·07 1·01	0·95 1·66	1·00	1·57 1·65
	Yield§	+ +	+ +	+	+ +
b	Coll. 1·2% Ph. 5·3	1 filter	2 filters	•• ••	
	Level U	448 224	168 28	30 6	448 224
	y	0·98 1·11	0·92 1·44	0·90 0·80	1·07 1·63
	Yield	+ +	− +	− −	+ +
c	Coll. 2·4% Ph. 5·3	1 hour 2 filters			
	Level U	240	120	16	360 240
	y	0·95	1·44	0·68	0·77 1·21
	Yield	+	+	−	− +

* Groups of five mice, strain *MAC*, were injected with the same dose of extract, except in groups marked **, where three mice per dose were used.
† Unit-level per 24 hr. urine specimen.
‡ y = average log uterine weight (mgm.) in each group.
§ + = more than minimum quantity of gonadotrophic hormone present as demonstrated by y for the number of animals used. − = less than that. For statistically analysed criteria, see Van Gilse (ref. 3).

after shaking the urine for at least one hour, a great amount of gonadotrophic activity was present in the final filter extract. Further experiments were carried out using one half, one, or two filters, prepared from 1·2, 1·8 or 2·4 per cent collodion solution per 500 ml. of urine. The results are summarized in Table 1.

It appears from the results that maximal adsorption was achieved when urine was shaken with two 2·4 per cent collodion filters for one hour, or with three 1·2 per cent filters for two hours (Exps. *c* and *b*). In both instances no gonadotrophic activity was demonstrated in the urine after being shaken. In none of the experiments, however, was there exactly the same quantity of gonadotrophic hormone activity as that present in the control urine, the minimum loss being an estimated 10–20 per cent.

Although our results are not sufficient to establish statistical calculation, it can be concluded that 80–90 per cent of the gonadotrophic hormone in urine concentrated by ultrafiltration is adsorbed on the filters. By improving the technique of adsorption and by changing shaking conditions it may be possible to improve the yield.

It is significant that, from these experiments, adsorption plays a major part in the concentration of gonadotrophins from urine by so-called ultrafiltration.

I am indebted to Dr. P. Grabar for his suggestions, to Prof. A. Querido and Dr. A. A. H. Kassenaar for interest in the experiments.

HENRIETTE A. VAN GILSE*
Department of Clinical Endocrinology
and Diseases of Metabolism,
University Hospital, Leyden.
Dec. 1.

* Present address: Rotterdam Radiotherapeutisch Institute, 323 Bergweg, Rotterdam.

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Gonadotrophic Action of Corticosteroids in *Xenopus laevis* and its Isolated Ovary

IT has been shown that progesterone[1] and certain related steroid compounds such as testosterone, methyltestosterone, androstenedione[2] and 11-deoxycorticosterone[3] will cause ovulation when injected into *Xenopus laevis*. Ovulation was induced also in the excised ovary suspended in frog's Ringer solution by the addition of progesterone[1], testosterone and androstenedione[4].

It has now been found that the following additional corticosteroids will induce ovulation when injected either into the dorsal lymph sac or intraperitoneally in 5–10 mgm. doses: corticosterone, 11-dehydrocorticosterone, cortisol and cortisone.

These corticosteroids and also 11-deoxycorticosterone caused extrusion of numerous ova when an excised ovary was suspended in 20 ml. of frog's Ringer to which 1 mgm. of the steroid was added. The results indicate that 11-deoxycorticosterone is as potent as progesterone but much more potent than the other corticosteroids. Corticosterone and 11-dehydrocorticosterone are more active than cortisol and cortisone.

All the experiments were performed during October and November, that is, just after the end of the breeding season, with animals freshly brought in from the ponds.

Since the completion of these experiments, 17-hydroxy-11-deoxycorticosterone became available, and it was found that it had the same gonadotrophic action as the other corticosteroids. We wish to thank Messrs. Ciba, Ltd., Basle, for a supply of this steroid.

One of us (A. C. J. B.) is in receipt of grants from the Union Government and from the Netherlands Organization for Pure Research (Z.W.O.).

A. C. J. BURGERS
H. ZWARENSTEIN

Dept. of Physiology and Pharmacology,
University of Cape Town.
Dec. 6.

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Grafting and Hybridization Experiments in the Genus *Trifolium*

Trifolium is a genus displaying very little interspecific compatibility, and any methods which would make possible species hybridization are worthy of trial. Michurinist geneticists in the U.S.S.R. claim that 'vegetative rapprochement' can be used for making distant crosses compatible. This led us to explore the possibilities of applying such grafting methods in the genus *Trifolium*. There is an abundance of literature available on this subject, but only a few examples relating to this work will be cited here.

The first record of grafting in the clovers, known to us, is that of Biffen[1] when he "tested the possibility of obtaining improved varieties of cultivated plants by employing the process of grafting". Recently, Hely, Bonnier and Manil[2] grafted *Trifolium repens* on to *T. ambiguum* and achieved good success. Again, Dyba[3] has shown that by grafting prior to crossing it has been possible to obtain interspecific and intergeneric hybrids of several grasses and leguminous forage plants. A method of embryo grafting has also been used for overcoming incompatibility, but this is not applicable to clover because of the small size of the seed.

In the present work, which was begun in Svalöf in 1950 and continued at Aberystwyth since then, seven *Trifolium* species, considered to be of agronomic importance, were chosen, namely, *T. pratense*, *T. medium*, *T. repens*, *T. hybridum*, *T. incarnatum*, *T. alexandrinum* and *T. subterraneum*. These were grafted interspecifically in all combinations, and intraspecific grafts were also made, giving forty-nine groups in all. Grafting was carried out in the spring when a shoot about 1 in. long was taken and prepared by slicing the base into a wedge shape. All leaves which had unfolded were removed, thereby reducing transpiration. This scion was then inserted into a split made in the node of the stock, and bound in position with a narrow band of wet raffia, or by using an auto-adhesive bandage. The treated plants were retained in a glass-topped frame covered with fine muslin. A high humidity was maintained, and the plants were left in the frame for about three weeks until the grafts had established themselves. Some of the grafts produced roots; these were removed,

so that the scion became totally dependent on the stock.

The percentage success of grafting in the first years (1950 and 1951) was rather low, and some of the graft combinations did not succeed at all. In 1952 seedling grafts where the scion was inserted into the split crown of the stock were tried and found to be highly successful, a 90 per cent success being often achieved between compatible species.

Before making the crosses of stock × scion and the reciprocal, it was important to know if pollen production was affected by grafting. There proved to be no significant differences between the measurements and counts of the pollen grains in the grafted and ungrafted plants.

As a result of crosses made in 1950 and 1951, no hybrid seed was obtained; but it became evident that one effect of grafting was to increase the self-fertility of the grafts. This is possibly due to wounding of the tissues, and the self-fertility may be a form of compensation for the plant. Further observations are being made together with an examination of the methods of emasculation.

In some of the attempted hybridizations, the pollen did not germinate on the style of the other species. To facilitate pollen germination, the stigma was painted with a solution of the hormone β-naphthoxyacetic acid[4], which acted as a substrate for the pollen; germination was then successfully effected in some cases. In order to trace the growth of pollen tubes down the style, the pollen tubes were stained with cotton blue in lactophenol. However, it was very difficult to trace the entry of the pollen tube into the ovule. In an endeavour to determine whether fertilization had taken place, different ovules of the same head were measured daily after pollination. Some of the ovules were observed to increase in size, and after about eight days it was possible to detect an embryo on dissecting the ovule. Quite frequently, however, the ovules shrivelled after ten days, and it seemed that the developing hybrid embryo could not grow on the endosperm.

As a next step in these studies it is proposed to attempt to salvage these embryos before abortion and to grow them in culture. Up to the present, no mature hybrids have been successfully produced; but there is evidence of fertilization in some of the species combinations.

On comparing the results of crossing ungrafted plants with those of attempted crosses between stock and scion, there seemed to be little difference as judged by the number of incipient hybrid embryos; in those inter-species combinations where grafting did not succeed, there was likewise no evidence of incipient embryo development. It appears, therefore, that a correlation exists between the success of grafting and the success of hybridization, or at least fertilization. In a genus like *Trifolium*, where there are about 250 species, it is obviously impracticable to make all the possible combinations by hybridizing. The grafting technique can thus possibly serve as a sieving-out process, since it would appear from these studies that only those species which graft successfully will be likely to hybridize. This correlation between success of grafting and of interspecific hybridization has been noted by workers on *Theobroma* species[5], and they suggest that possibly the success of hybridization and grafting have a common physiological basis.

The work on increased self-fertility as a result of grafting is being continued at Svalöf, and the work on hybridization and embryo culturing is in progress at Aberystwyth, detailed results of which will be published elsewhere.

Alice M. Evans

Welsh Plant Breeding Station,
Aberystwyth.

Thore Denward

Swedish Seed Association,
Svalöf, Sweden. Dec. 21.

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Shikimic Acid as a Precursor in Lignin Biosynthesis

The role of shikimic acid and related compounds in the biosynthesis of the aromatic ring by mutants of *E. coli* has recently been the subject of extensive study by Davis and his associates[1]. Their work has indicated that shikimic acid is an important precursor of the aromatic structure in this organism. The reaction sequence by which this compound is aromatized is still not fully understood, but it is believed[2] that prephenic acid is one of the intermediates and that the first aromatic compound formed is phenylpyruvic acid. The above findings have raised the question of the existence of a similar biosynthetic pathway in higher plants, and we have now investigated this possibility during current studies on the origin of lignin, one of the principal aromatic plant constituents.

Early work on the chemistry of lignin[3] led to theories that it is a polymer of some unit having a phenylpropane skeleton (a C-6, C-3 structure). Recently, Freudenberg and his co-workers[4] have adduced further evidence in support of this concept by their finding that coniferyl alcohol undergoes polymerization to a lignin-like substance in the presence of oxidizing enzymes from *Araucaria*. Siegel[5] has reported that eugenol fed to *Phaseolus vulgaris*, and eugenol and ferulic acid given to *Elodea densa*, were effective in stimulating the synthesis of substances giving characteristic lignin tests. For comparison with shikimic acid as a lignin precursor we have, therefore, chosen a C-6, C-3 aromatic compound, L-phenylalanine, which is especially suitable because of its widespread occurrence and close structural and metabolic[6] relationship to phenylpyruvic acid. We have also studied protocatechuic acid, as a representative of naturally occurring aromatic compounds with a one-carbon side-chain.

Wheat (*Triticum vulgare* Vill., var. Thatcher) and ash-leaved maple (*Acer negundo* L., var. *interius*) were the plants used in these experiments. Labelled shikimic acid was prepared by fermentation of randomly carbon-14-labelled glucose with *E. coli* mutant 83–24, provided through the courtesy of Dr. Bernard Davis. Randomly labelled L-phenylalanine was purchased from Atomic Energy of Canada, Ltd., and protocatechuic acid was synthesized by demethylation of carboxyl-labelled vanillic acid[7] with hydrogen iodide. These compounds (0·10–0·135 m. mole) were fed by absorption of a small volume (1 ml.) of their aqueous solutions through the cut ends of the stems or twigs. After transfer to water, the plants were allowed to metabolize during 24 hr. beside a

Table 1. UTILIZATION OF LABELLED COMPOUNDS IN LIGNIN BIOSYNTHESIS

Plant	Compound administered	μc. ^{14}C/m.mole of administered compound (*a*)	μc. ^{14}C/m.mole of vanillin (V) or syringaldehyde (S) (*b*)	Dilution $\left(\frac{a}{b}\right)$
Wheat	Shikimic acid	24·4	V 0·525	46·5
			S 0·596	41·0
	L-Phenylalanine	20·8	V 0·338	61·5
			S 0·421	49·5
Maple	Shikimic acid	24·4	V 0·112	220 (210*)
			S 0·072	339 (326*)
	L-Phenylalanine	31·3	V 0·303	103
			S 0·120	260
	Protocatechuic acid†	115·0	V negligible	—
			S negligible	—

* Corrected for dry weight of plant to enable direct comparison with the phenylalanine figures. Dry weight of wheat, 1·2–1·4 gm.; of maple, 2·7–4·0 gm.
† Fed as the potassium salt at *p*H 6.

north window at 20–25° C. They were then dried and ground, and the cell-wall fraction was prepared and oxidized with nitrobenzene essentially as reported earlier[8]. Vanillin and syringaldehyde from the oxidation were isolated as the *m*-nitrobenzoylhydrazones following their separation on Whatman 3*MM* paper sheets[9]. The determination of carbon-14 was carried out by wet combustion of the samples and analysis of the carbon dioxide in a gas-phase counter[10].

The last column of Table 1 shows the dilutions in the specific activity of the different labelled precursors during their conversion to lignin. Because of differences in the weight of the plant material and in conditions of growth prior to the experiment, the results cannot be compared quantitatively between the two species; but they are comparable within each species. It can be seen that the efficiency with which shikimic acid is converted to the vanillin- and syringaldehyde-yielding lignin residues is of the same order as that of phenylalanine. In contrast, protocatechuic acid, an aromatic compound which resembles vanillin in the position of its substituents, is not measurably transformed to lignin. It appears, therefore, that shikimic acid is readily convertible by the plant to some compound closely allied to phenylalanine, which is a lignin precursor. The results (unpublished) which we have obtained with other C-6, C-1 aromatic compounds (benzoic, *p*-hydroxybenzoic and anisic acids), as well as the above results on protocatechuic acid, lead to the conclusion that this transformation probably does not involve an aromatic compound possessing only one side-chain carbon.

In view of the above findings, it seems likely that a pathway of aromatic biosynthesis similar to that found by Davis *et al.* in *E. coli*[1,2], involving prephenic and phenylpyruvic acids, also exists in plants. The sequence of reactions in this stage of lignin formation would appear to be: (1) attachment of a three-carbon side-chain to a non-aromatic ring, (2) aromatization and (3) substitution of the ring.

The demonstration that shikimic acid can serve as an aromatic precursor in *Triticum* and *Acer* raises the question of the ubiquity of this compound among higher plants. It is of interest that Hasegawa and co-workers[11] have recently shown its occurrence in forty-nine species, indicating considerably more widespread distribution than was previously believed.

Further details of this and related work will be submitted to the *Canadian Journal of Biochemistry and Physiology*. We wish to thank Dr. R. Y. Stanier, of the University of California, who suggested testing shikimic acid, Drs. F. J. Simpson and Ping Shu, who carried out the fermentation, and Messrs. F. M. Clare and John Dyck, who assisted with the analyses.

STEWART A. BROWN
A. C. NEISH

National Research Council,
Prairie Regional Laboratory,
Saskatoon, Saskatchewan.
Dec. 10.

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Internal Seed Disinfection by an Antibiotic from *Streptomyces rimosus*

INVESTIGATIONS have been carried out on the systemic fungicidal action of substances from cultures of several fungi (including Actinomycetes) and bacteria. A suspension, obtained from a culture of *Streptomyces rimosus* from the Centraal Bureau voor Schimmelcultures at Baarn, Holland, behaved as a potent antibiotic against some bacteria and fungi, for example, *Ascochyta pisi* and *Mycosphaerella pinodes*.

These fungi are, in the Netherlands, especially in wet years, common parasites in pea seeds. External seed treatment is ineffective because of the deep-seated nature of infection. The above-mentioned suspension was active against both of them in pea seeds.

Seeds of peas, heavily infected with *Ascochyta pisi*, were used for testing the fungicidal properties of the antibiotic substances and their ability to penetrate into the seeds. The seeds were soaked in the solution or the suspension to be tested for different periods. Then the seeds were placed on wet filter paper in a moist chamber at room temperature. The effect of the treatment was determined after one week, by counting the number of seeds developing *Ascochyta* mycelium on the seed coat.

Experiments were carried out with a suspension obtained by grinding a culture of *Streptomyces rimosus*, grown on agar, in a Waring blendor, and mixing this mass with a definite quantity of water. In the following, this suspension is referred to as 'rimag'. Soaking infected pea seeds in 'rimag' for 18 hr. reduced considerably the number of seeds developing *Ascochyta pisi* mycelium (Table 1).

Table 1. PERCENTAGES OF HEAVILY INFECTED SEEDS DEVELOPING *Ascochyta* MYCELIUM AFTER SOAKING FOR 18 HR. IN 'RIMAG' OR WATER

Variety	Soaked in	No. of seeds	Per cent seeds developing *Ascochyta* mycelium
Dopper Eminent	'rimag'	120	8·5
Dopper Eminent	water	120	77
Servo	'rimag'	200	6
Servo	water	200	60

Table 2. Emergence of Healthy and Infected Seeds, planted in Sterilized Soil, after Soaking in 'Rimag' or Water for 18 hr.

Variety	Soaked in	No. of seeds	Emergence
Rondo, healthy	'rimag'	100	93
Rondo, healthy	water	100	90
Dopper Eminent, diseased	'rimag'	100	66
Dopper Eminent, diseased	water	100	66

After a week, the length of the rootlets of the 'rimag'-treated seeds in this test was the same as for seeds treated with water. However, when 'rimag' was prepared from a culture older than two weeks, there was evidence of toxicity.

Soaking healthy or infected seeds in 'rimag' for 18 hr. did not decrease emergence in sterilized soil (Table 2).

To prove that an antibiotic substance in 'rimag' penetrated into the seeds, pieces of the inside of treated seeds were placed in Petri dishes on agar, seeded with a bacterium that is inhibited by 'rimag' *in vitro*. The inhibition zones caused by these pieces indicated that at least one antibiotic component of the suspension had penetrated into the seeds.

It was also demonstrated that *Mycosphaerella pinodes*, present within seeds of peas, is killed by treatment with 'rimag'.

According to the literature, *Streptomyces rimosus* produces at least two antibiotics, namely, terramycin and rimocidin. Terramycin, which is not reported to have any fungicidal activity, did not inhibit *Ascochyta pisi* either *in vitro* or *in vivo*. Rimocidin is known as a fungicide[1], but systemic action of this compound has not been reported.

By the courtesy of Chas. Pfizer and Co., Inc., who sent us crude rimocidin (760 μgm./mgm.), this antibiotic was tested. It was demonstrated that rimocidin penetrates into pea seeds and has fungicidal activity against *Ascochyta pisi* both *in vitro* and *in vivo*. Soaking in a solution of rimocidin at concentrations of 25 and 50 p.p.m. decreased the number of seeds with mycelial growth of *Ascochyta pisi* appreciably, and treatment with a solution of 100 p.p.m. gave nearly complete control (Fig. 1).

Soaking for 18 hr. in rimocidin at 200 p.p.m. did not depress germination and emergence of the seeds in sterilized soil. The growth of plants from these seeds was not impaired. This indicates that there is a considerable difference between the fungicidal and the phytotoxic concentrations of this antibiotic.

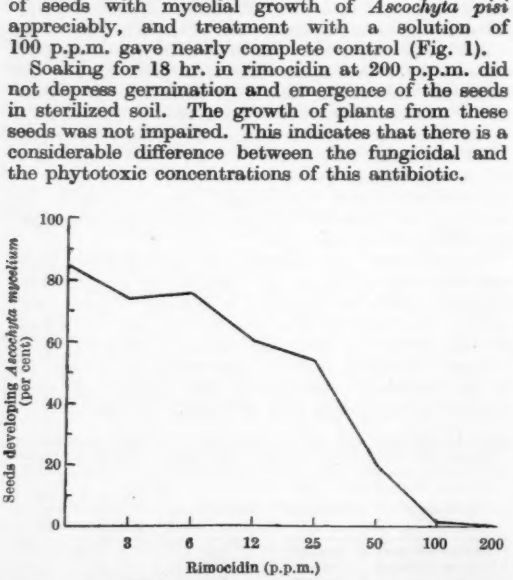

Fig. 1. Percentages of seeds, var. Dopper Eminent, developing *Ascochyta* mycelium after soaking for 18 hr in various concentrations of rimocidin

I am indebted to Chas. Pfizer and Co., Inc., for providing the rimocidin, and to Miss E. Goedbloed for assistance.

J. Dekker

T.N.O.-Z.W.O. Research Unit
for Internal Therapy of Plants,
Laboratory of Phytopathology,
Agricultural University,
Wageningen, The Netherlands.
Dec. 6.

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A Marine Bacteriophage

One of the main difficulties in the study of marine bacteria, and particularly of those types which constitute the flora of fresh and spoiling fish, is that of identification and classification. This is due to the negative results given by these bacteria in most common biochemical tests. It was considered that the use of bacteriophage might help with this difficulty, and consequently attempts were made to isolate bacteriophages active against certain marine bacteria associated with fish, and particularly against certain luminous bacteria probably identical with *Photobacterium phosphoreum* (*Bacterium phosphoreum* Bergey[1]). These luminous bacteria have been shown by various workers to constitute a considerable part of the flora of many species of fish[2].

Various methods of isolation were attempted, and the following one proved successful. To 100 ml. of quadruple strength sea-water 'Lemco' broth ('Lemco' 4 per cent, peptone 4 per cent, aged sea-water 75 per cent, tap-water 25 per cent, *p*H 7·6) were added 300 ml. of sea-water taken approximately ten miles east-south-east of Aberdeen, together with 8 ml. of an overnight sea-water 'Lemco' broth culture of each of four different strains of luminous bacteria. This was incubated at 20° C. for 48 hr., Seitz-filtered, and the filtrate tested for lytic action on the surface of sea-water 'Lemco' agar plates previously inoculated with the appropriate bacterial strain. This method of isolation was repeated many times with various bacterial strains. Bacteriophage was isolated in only one case. The bacteriophage was purified by several single-plaque isolations and increased in titre by plate lysis.

As the bacteriophage was obtained from a mixed culture, that is, four strains grown together, there was a possibility that it originated, not from the sea-water, but from a lysogenic strain. This possibility was disproved by testing the strains for lysogenicity by Fisk's[3] method; none was lysogenic. The four strains were also grown together in further samples of sea-water under identical conditions to the experiment which resulted in bacteriophage. This failed to yield further bacteriophage. It thus appears that sea-water far from land does contain bacteriophage, but only sparsely.

Several workers have examined sea-water for the presence of bacteriophages, and although bacteriophages active against various enterobacteria have been isolated from polluted sea-water, none has been isolated which is active against marine bacteria[4]. Also, this is only the second[5] reported isolation of a bacteriophage active against luminous bacteria.

Fig. 1 shows lysis of several strains of luminous bacteria, one strain being resistant: (*a*) was taken by

Table 1

Time of exposure (min.)												Temp. °C.
0	1	2	3	4	5	7½	10	12½	15	20	30	
+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	40
+++	+++	+++	+++	++	++	+	+	+	±	−	−	45
+++	+++	−	−	−	−	−	−	−	−	−	−	50

+++, Confluent lysis; ++, confluent plaques; +, many isolated plaques; ±, few isolated plaques; −, no lysis

artificial light and (*b*) is the same Petri dish photographed by the luminescence of the bacteria (exposure of 90 min., lens-object distance 50 cm., aperture *f*8, Kodak *P*200 plate). It can be seen that the luminescence of the resistant secondary growth was in no way affected.

The question of which characteristics distinguish marine micro-organisms from related terrestrial forms is a much debated one, but such characteristics as the ability to grow at temperatures near 0° C., the preference for salinity in the range 3–4 per cent or at least as good growth in this range as at 0·5–1 per cent, and, in general, a lower heat tolerance than terrestrial forms, are generally accepted. The bacteriophage isolated possesses all these characteristics. It will cause lysis on a sea-water 'Lemco' agar medium at 0° C. It will not cause lysis on a tap-water 'Lemco' agar containing 0·5 per cent sodium chloride, although the host strain grows well on this medium. Addition of sodium chloride up to 2–3 per cent to the tap-water medium allows lysis to take place.

There have been several studies of the heat tolerance of bacteriophages, and in general it may be said that terrestrial ones are not appreciably inactivated by exposure in broth to 60° C. for 10–30 min. Indeed, some *coli*-phages are not inactivated at all by exposure to 65° C. Table 1 shows the inactivation of the marine bacteriophage in sea-water 'Lemco' broth.

Standard loopfuls were taken from the broth at the intervals indicated and tested for lytic activity on sea-water 'Lemco' agar plates. The original titre of the bacteriophage was such that a loopful of a 1 in 10,000 dilution gave confluent plaques. It can be seen that the marine bacteriophage is much less tolerant of heat than terrestrial bacteriophages.

The above characteristics confirm that the bacteriophage is of marine origin and support the thesis that there is a typical marine microbiological flora.

A more detailed study of the properties of this bacteriophage and its use in classification will be reported elsewhere.

This work was carried out as part of the programme of the Food Investigation Organization of the Department of Scientific and Industrial Research.

R. SPENCER

Humber Laboratory,
Food Investigation Organization
(Department of Scientific and
Industrial Research),
Hull.
Feb. 7.

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Enzymatic Production of Carbon Dioxide in *Hevea* Latex

EARLY investigators of *Hevea* latex were aware that fresh latex always contained considerable amounts of free carbon dioxide.

Van den Tempel in some recent analyses found 114 milliequivalents of carbon dioxide per litre of serum in old ammoniated latex and 66 milliequivalents in commercial concentrated latex. We do not, however, think it generally appreciated that latex contains an active 'carboxylase' system (no evidence has been obtained that pyruvic acid is the precursor of the carbon dioxide). At tapping, we have found fresh latex to contain about 20 milliequivalents of carbon dioxide per litre of serum; if the latex is allowed to stand at atmospheric temperature, this increases after 6 hr. to 85. The estimation of carbon dioxide was carried out by aspirating carbon dioxide-free air through latex, acidified with hydrochloric acid and stabilized with 'Vulcastab LW', into standard baryta solution.

The carbon dioxide content plotted against the time after tapping follows a linear relationship, indicating an apparent zero-order enzymatic reaction. After 5–6 hr. the rate of formation falls off somewhat but the kinetics of the later reaction have not yet been followed. It might be expected that after six hours or so, bacterial activity would set in, and this would complicate the issue. The reaction virtually ceases at *p*H 8 (by addition of 0·03 per cent ammonia) and is almost entirely inhibited by 0·05–0·075 per cent of formaldehyde or 0·01–0·02 per cent of sodium fluoride. It now becomes very clear why the properties of preserved latex are so much affected by the interval which elapses between time of tapping

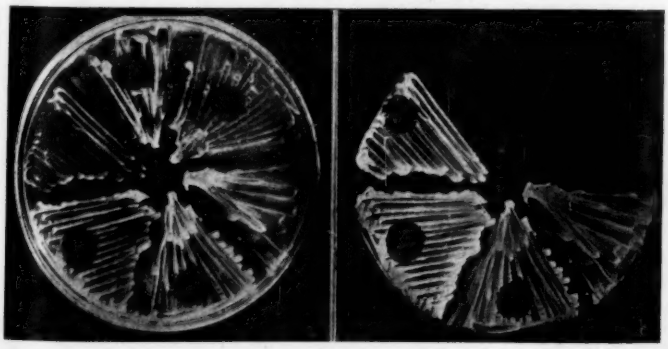

Fig. 1

and the time of preservation. We thank Dunlop Malayan Estates, Ltd., for permission to publish these preliminary findings.

F. J. Paton
H. M. Collier

Dunlop Research Centre,
Batang Malaka,
Negri Sembilan, Malaya.
Dec. 14.

The Protein from *Balanites aegyptica*

The only reported study of the protein of *Balanites aegyptica* is an abstract from a thesis by Despujols[1], who showed the presence of two fractions, 70–75 per cent of balanine ("insoluble in water in the presence of salts") and 25–30 per cent of aegyptine (soluble under the same conditions). It was claimed that the two fractions can be separated by dialysis, but the use of salts did not give a complete separation. No details regarding the method of extraction of the protein from the nut were given. In this communication a brief ultracentrifugal study of a saline extract of the protein is presented.

The nuts of *Balanites aegyptica* from Sudan (lalob nuts) were shelled, ground and the oil removed with petroleum ether. Using a 1 : 10 meal : liquor ratio, the de-oiled meal, containing 8·6 per cent nitrogen, was extracted with 10 per cent (w/v) sodium chloride solution, the protein precipitated by saturation to 85 per cent with ammonium sulphate and purified by a similar reprecipitation from 10 per cent sodium chloride solution. The nitrogen content of the protein was 17·1 per cent and its partial specific volume 0·685 (± 0·005).

Examination of the protein after dialysis against phosphate buffer (ionic strength, $I = 0{\cdot}5$, pH = 8) in the 'Spinco' Model *E* ultracentrifuge at *c.* 200,000 *g* showed the presence of two main components, of sedimentation constants (s) 12·3 and *c.* 2 *S* (Svedberg units, Fig. 1*a*). The fractions precipitating from a 10 per cent sodium chloride extract at between 0–40 and 40–85 per cent saturation with ammonium sulphate were redissolved in 10 per cent sodium chloride, reprecipitated and, after dialysis, were examined in the same buffer in the ultracentrifuge. Fig. 1*b* shows the sedimentation diagram of the 0/40 fraction, which consisted mainly of the $s_{12\cdot3}$ component with a small amount of s_{18} and some s_2 component. The 40/85 fraction, on the other hand, contained most of the slowly sedimenting material, and also a small amount of s_8 material as well as the $s_{12\cdot3}$ component. The fractionation, however, was by no means sharp.

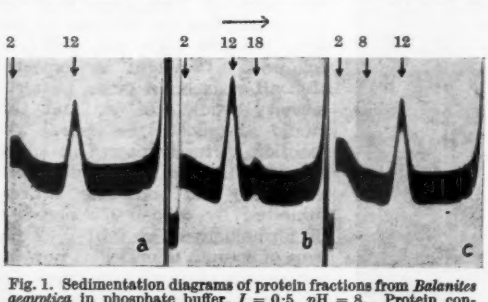

Fig. 1. Sedimentation diagrams of protein fractions from *Balanites aegyptica* in phosphate buffer, $I = 0{\cdot}5$, pH = 8. Protein concentration = 0·8 gm./100 ml. (*a*) 0/85 fraction; (*b*) 0/40 fraction; (*c*) 40/85 fraction. Numbers above peaks refer to rounded sedimentation constants in Svedberg units

No appreciable changes in the sedimentation diagram of any of the fractions were observed on lowering the ionic strength to 0·05. Thus, dissociation–association reactions brought about by ionic strength changes, which are characteristic of some other proteins, appear to be absent in this system.

In the absence of sufficient published data, no correlation of the sedimenting components reported in this work with the fractions of Despujols has been attempted.

W. E. F. Naismith

'Ardil' Fibre Factory,
Imperial Chemical Industries, Ltd.,
Nobel Division,
Dumfries.
Dec. 16.

[1] Despujols, J., "L'Année Biologique", **24**, 203 (1948).

Rabbit Fleas on Wild Rabbits and the Transmission of Myxomatosis

During the course of investigations into myxomatosis on the Heisker or Monach Isles, North Uist, it was suspected that the rabbit flea, *Spilopsyllus cuniculi* (Dale), was responsible for the carry-over of the disease during the winter of 1952–53. Laboratory experiments confirmed that the rabbit flea could transmit the disease, and this was also shown by Lockley[1]. Since December 1953 a census of the flea population on wild rabbits has been carried out on an estate near Aberdeen, and the accompanying histogram (Fig. 1) illustrates the results.

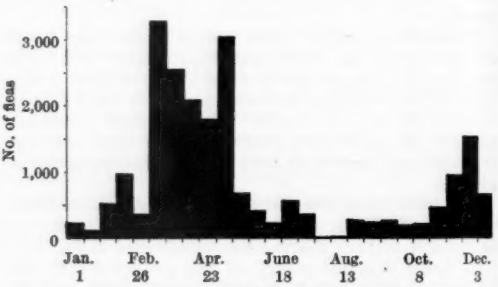

Fig. 1. Total number of fleas taken from twenty rabbits at fortnightly intervals

The census is being continued for a further period in order to establish whether or not the increase in the population during March and November is characteristic of this species.

It is of interest to record that it has been found that, under laboratory conditions at least, *Ixodes reduvius* can also be a vector of myxomatosis virus.

R. M. Allan

Entomology Department,
Marischal College,
Aberdeen.

P. L. Shanks

Veterinary Investigation Department,
Mill of Craibstone,
Bucksburn,
Aberdeenshire.
Dec. 17.

[1] Lockley, R. M., *Vet. Rec.*, **66**, No. 30 (1954).

FORTHCOMING EVENTS

Monday, April 18

SOCIETY OF CHEMICAL INDUSTRY, PESTICIDES GROUP (in the Rooms of the Chemical Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Annual General Meeting, 5.55 p.m.—Mr. G. L. Baildit: "The Development of a New Pesticide".

SOCIETY FOR GENERAL MICROBIOLOGY (at the Royal Institution, Albemarle Street, London, W.1), at 6 p.m.—Prof. C. B. van Niel (U.S.A.): "Natural Selection in the Microbial World" (Second Marjory Stephenson Memorial Lecture).

INSTITUTE OF METAL FINISHING (joint meeting of the LONDON BRANCH AND ORGANIC FINISHING GROUP, at the Northampton Polytechnic, St. John Street, London, E.C.1), at 6.15 p.m.—Mr. R. Tilney: "Electrostatic Painting Processes"; followed by a film on "Electrostatic Spraying".

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 8.30 p.m.—Dr. E. B. Worthington: "East Africa and Her Neighbours".

Tuesday, April 19

INSTITUTION OF ELECTRICAL ENGINEERS, MEASUREMENTS SECTION (at Savoy Place, London, W.C.2), at 5.30 p.m.—Discussion on "The Measurement of Impulse Voltages and Currents with special reference to the Testing of Surge Diverters".

SOCIETY OF CHEMICAL INDUSTRY, PLASTICS AND POLYMER GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6 p.m.—Annual General Meeting, followed by three short papers on "Polyester Resins".

ROYAL AERONAUTICAL SOCIETY (in the Library, 4 Hamilton Place, London, W.1), at 7 p.m.—Prof. W. S. Hemp: "Thermoelasticity".

Tuesday, April 19—Wednesday, April 20

SOCIETY FOR GENERAL MICROBIOLOGY (at the Royal Institution, Albemarle Street, London, W.1)—Symposium on "Mechanisms of Microbial Pathogenicity".

Tuesday, April 19—Friday, April 22

UNIVERSITY OF MANCHESTER (at the University)—Symposium on "Astronomical Optics and Related Subjects".

Wednesday, April 20

ROYAL METEOROLOGICAL SOCIETY (at 49 Cromwell Road, South Kensington, London, S.W.7), at 5 p.m.—Annual General Meeting.

ROYAL STATISTICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Mr. K. F. Lane and Dr. J. E. Andrew: "A Method of Labour Turnover Analysis".

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO SECTION (at Savoy Place, London, W.C.2), at 5.30 p.m.—Dr. G. H. Metson: "A Study of the Long-Term Emission Behaviour of an Oxide Cathode Valve".

ROYAL MICROSCOPICAL SOCIETY (at Tavistock House South, Tavistock Square, London, W.C.1), at 5.30 p.m.—Mrs. M. W. Gardiner: "Notes on the Refraction Ring in Bubbles".

Thursday, April 21

ROYAL INSTITUTE OF CHEMISTRY (joint meeting with the CHEMICAL SOCIETY, the INSTITUTE OF PETROLEUM and the SOCIETY OF CHEMICAL INDUSTRY, in the Chemistry Lecture Theatre, The University, Manchester), at 10.30 a.m.—Symposium on "Organo-Metallic Compounds".

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Dr. A. G. Gaydon, F.R.S., Mr. N. P. W. Moore and Mr. J. R. Simonson: "Chemical and Spectroscopic Studies of Blue Flames in the Auto-ignition of Methane"; Mr. N. Gregory, Mr. J. T. Stuart and Mr. W. S. Walker: "On the Stability of Three-dimensional Boundary Layers with Application to the Flow due to a Rotating Disk".

INSTITUTION OF MINING AND METALLURGY (in the Apartments of the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. F. A. Schaufelberger and Dr. T. K. Roy: "Separation of Copper, Nickel and Cobalt by Selective Reduction from Aqueous Solution"; Mr. H. A. Graves: "A Decade of Progress in Canadian Mining (1945–1954)—Part 1".

LINNEAN SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. J. Heslop Harrison, F.R.S.: "Natural Hybridization and Its Consequences in British Dactylorchids".

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, London, W.C.2), at 5.30 p.m.—Dr. W. Shockley: Forty-Sixth Kelvin Lecture on "Transistor Physics".

ROYAL AERONAUTICAL SOCIETY (at the Institution of Mechanical Engineers, 1 Birdcage Walk, Westminster, London, S.W.1), at 6 p.m.—Major Bo. K. O. Lundberg: "Aeronautical Research in Sweden".

SOCIETY OF CHEMICAL INDUSTRY, ROAD AND BUILDING MATERIALS GROUP (in the Lecture Hall of the Institution of Structural Engineers, 11 Upper Belgrave Street, London, S.W.1), at 6 p.m.—Annual General Meeting.

Friday, April 22

INSTITUTION OF ELECTRICAL ENGINEERS, EDUCATION DISCUSSION CIRCLE (at Savoy Place, London, W.C.2), at 6 p.m.—Discussion on "Technical Training in North-West Germany".

SOCIETY OF CHEMICAL INDUSTRY, FINE CHEMICALS GROUP (in the Chemistry Lecture Theatre, King's College, Strand, London, W.C.2), at 7 p.m.—Annual General Meeting; 7.30 p.m.—Chairman's Address.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

SENIOR ASSISTANT PHYSICIST (with an honours degree in physics, and previous experience in hospital physics) IN THE RADIOTHERAPY AND X-RAY DIAGNOSTIC DEPARTMENTS—The Personnel Officer, St. Thomas's Hospital, London, S.E.1 (April 23).

ASSISTANT LECTURER IN MATHEMATICS—The Registrar, The University, Hull (April 25).

LECTURER (with an honours degree in physics and preferably able to teach the subject to a high standard) IN PHYSICS—The Principal, Wigan and District Mining and Technical College, Wigan (April 25).

SENIOR LECTURER IN PHYSICS at Fourah Bay College (University of Durham), Sierra Leone—The Secretary, Advisory Committee on Colonial Colleges, 1 Gordon Square, London, W.C.1 (April 25).

SENIOR LECTURER, LECTURER, or ASSISTANT LECTURER in (*a*) MATHEMATICS; (*b*) BOTANY; (*c*) AGRICULTURAL BOTANY; and (*d*) AGRICULTURAL CHEMISTRY, at the University College of Khartoum, Sudan—The Secretary, Inter-University Council, 1 Gordon Square, London, W.C.1 (April 29).

ASSISTANT LECTURER IN BACTERIOLOGY—The Registrar, University College of South Wales and Monmouthshire, Cathays Park, Cardiff (April 30).

ASSISTANT LECTURER (with special qualifications in organic chemistry) IN CHEMISTRY—The Registrar, The University, Manchester 13 (April 30).

CHEMIST (with a degree in science, preferably with honours in inorganic and physical chemistry) IN THE SECTION OF SOIL CHEMISTRY, Department of Agricultural Chemistry, Waite Agricultural Research Institute, Adelaide, to conduct research into the chemical properties of soils, particularly in regard to fertility investigations—The Registrar, University of Adelaide, Adelaide, South Australia (April 30).

LECTURER, Grade II (with an honours degree in physics, and experience in the practical use of geophysical apparatus) IN GEOPHYSICS—The Secretary, The University, Edgbaston, Birmingham 15 (April 30).

LECTURER or ASSISTANT LECTURER (with experience of university teaching, and preferably with special qualifications in petrology) IN THE DEPARTMENT OF GEOLOGY—The Secretary and Registrar, The University, Southampton (April 30).

LECTURER (with good academic qualifications and industrial experience) IN ORGANIC CHEMISTRY, at Flintshire Technical College—The Director of Education, County Education Offices, Mold, Flintshire (April 30).

ASSISTANT LECTURER (with a good honours degree and special interests in stratigraphy) IN GEOLOGY—The Registrar, King's College, Strand, London, W.C.2 (May 6).

LECTURER or ASSISTANT LECTURER IN PHYSIOLOGY, and a SENIOR LECTURER or LECTURER IN PHYSIOLOGY—The Registrar, The University, Sheffield (May 7).

LECTURER (preferably with special qualifications in micro- and semi-micro analytical techniques) IN CHEMISTRY—The Secretary, The University, Aberdeen (May 7).

RESEARCH OFFICER (with a university honours degree or equivalent in physics or mechanical engineering, and preferably with research experience) IN THE WOOL TEXTILE RESEARCH LABORATORY, Commonwealth Scientific and Industrial Research Organization, Geelong, Victoria, Australia, for fundamental applied research concerned with the properties of fibre assemblies—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 464/81 (May 7).

SENIOR RESEARCH OFFICER or RESEARCH OFFICER (with a university honours degree in science with physics as a major subject, or equivalent qualifications, together with some years of postgraduate experience in appropriate fields) IN THE NATIONAL STANDARDS LABORATORY, Division of Metrology, Commonwealth Scientific and Industrial Research Organization, Sydney, N.S.W., Australia, to undertake research in the fields of optical interferometry or microwave interferometry with particular reference to length standardization and associated quantities—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 750/115 (May 7).

LECTURER (with a good honours degree in biochemistry or organic chemistry (natural products)) IN BIOCHEMISTRY—The Registrar, King's College, Strand, London, W.C.2 (May 9).

ASSISTANT LECTURER (with a good honours degree) IN BOTANY, to assist in microbiology (mycology)—The Registrar, King's College, Strand, London, W.C.2 (May 10).

READER IN ORGANIC CHEMISTRY at Birkbeck College—The Academic Registrar, University of London, Senate House, London, W.C.1 (May 12).

LECTURER (with special interests in inorganic chemistry) IN CHEMISTRY—The Registrar, King's College, Strand, London, W.C.2 (May 14).

LECTURER IN MATHEMATICS at the University of the Witwatersrand, Johannesburg, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (South Africa, May 16).

LECTURER IN METALLURGY, and a RESEARCH ASSISTANT (male or female, with experience in practical microscopy) IN THE DEPARTMENT OF METALLURGY—The Registrar, The University, Manchester 13 (May 31).

BIOCHEMIST, Scientific Officer grade (preferably with some mechanical aptitude), to study the composition and purification of large-scale preparations of leaf protein—The Secretary, Rothamsted Experimental Station, Harpenden, Herts, quoting "167".

EXPERIMENTAL OFFICER (with at least higher school certificate (science) or equivalent, and experience in bacteriological research) IN THE VIRUS RESEARCH UNIT of a Ministry of Supply Establishment, near Salisbury, Wilts—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting G81/5A.

EXPERIMENTAL OFFICERS (preferably with a pass degree in physics), and ASSISTANT EXPERIMENTAL OFFICERS (with at least H.S.C. in science subjects or equivalent), to assist in investigations in a variety of allied fields including neutron generation, nuclear counting systems

and the properties of radioactive materials—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting 77/WGE/34.

LECTURER or ASSISTANT PROFESSOR to teach courses in bacteriology and in public health and some other biological subjects—W. B. Stallworthy, Mount Allison University, Sackville, N.B., Canada.

LECTURER (with a degree in biochemistry and/or chemistry, including organic chemistry taken to an advanced stage, and preferably with experience in the analysis of foods, including dairy products) IN AGRICULTURAL BIOCHEMISTRY, at Massey Agricultural College (University of New Zealand), Palmerston North, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1.

PLANT BREEDER, Scientific Officer, Senior Scientific Officer or Principal Scientific Officer grade (with at least a second-class honours degree in botany, and two years postgraduate experience in cytology and genetics, preferably of tree crops) at the West African Cacao Research Institute, H.M. Oversea Civil Service, Gold Coast, to study the cytogenetics of theobroma and related genera and development of improved selections and hybrids—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting BCD.197/200/08.

PLANT PATHOLOGIST (with at least a second-class honours degree in botany and two years postgraduate experience) IN THE DEPARTMENT OF AGRICULTURE, Mauritius, to study and advise on control of diseases of economic plants, to take charge of the plant quarantine station, and to lecture in plant pathology at the Agricultural College—The Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting BCD.63/52/09.

RESEARCH CHEMISTS (with an honours B.Sc. in chemistry or A.R.I.C., and preferably with some plastics experience)—The Coal Tar Research Association, Oxford Road, Gomersal, near Leeds.

SCIENTIFIC OFFICER (with a first- or second-class honours degree in physics or electrical engineering or equivalent qualifications) at an R.A.F. Station near Maidenhead, Berks, for operational research duties, theoretical studies and development work in the field of communications and general electronics—Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.113/5A.

SENIOR MINERALOGIST (with a degree, with geology as a major subject, and with several years experience which has included some mineragraphy) IN THE MINES DEPARTMENT, Public Service of South Australia, for the examination of ore-dressing products and the study of opaque minerals in drill cores and geological specimens involving microscopic and microchemical techniques; and a SENIOR PETROLOGIST (with a degree, with geology as a major subject, and some years experience in sedimentary and hard rock petrology), for the petrographic examination of sands, soils and unconsolidated sediments as well as the interpretation of rock suites and drill cores in respect of field geological investigations—The Agent-General for South Australia, South Australia House, Marble Arch, London, W.1.

SENIOR SCIENTIFIC OFFICER or SCIENTIFIC OFFICER (with a first- or second-class honours degree in chemical engineering or in chemistry or in engineering with a chemical engineering diploma, and preferably with experience of the solution of fluid flow problems and liquid phase separations), for work on the design and development of plant for a special process involving the assessment of fundamental physico-chemical data, flowsheeting of processes and design of experimental and pilot equipments therefrom—Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting 559/WGE/34.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Observations made at the Royal Observatory, Greenwich, in the year 1945, in Astronomy, Magnetism and Meteorology, under the direction of Sir Harold Spencer Jones. Pp. viii+270+7 plates. (London: H.M. Stationery Office, 1954.) 70s. net. [271

Ministry of Education. Science Museum. Handbook of the Collection relating to Heat and Cold. Part 2: Catalogue of Exhibits with Descriptive Notes. By J. A. Chaldecott. Pp. 64+6 plates. (London: H.M. Stationery Office, 1954.) 3s. net. [281

Ministry of Fuel and Power. Reports of H.M. Inspectors of Mines under the Coal Mines Act, 1911, for the year 1953. Scottish Division. By W. Widdas. Pp. ii+26+6 plates. (London: H.M. Stationery Office, 1954.) 2s. net. [12

Bulletin of the British Museum (Natural History). Zoology. Vol. 2, No. 11: The Southern Right Whale Dolphin, *Lissodelphis Peroni* (Lacépède). By F. C. Fraser. Pp. 339–346+plate 12. (London: British Museum (Natural History), 1955.) 5s. [12

Institution of British Agricultural Engineers. Year Book 1954–55. Pp. 84. (Brighton: Fraser Pearce, Ltd., 1955.) [12

National Physical Laboratory. Notes on Applied Science No. 9: Measurement of Pressure with the Mercury Barometer. Pp. iv+15+1 plate. (London: H.M. Stationery Office, 1955.) 1s. net. [12

National Museum of Wales. Forty-seventh Annual Report, 1953–54. Pp. 63+4 plates. (Cardiff: National Museum of Wales, 1954.) [12

University of Cambridge. School of Agriculture Memoirs. Memoir No. 26: A summary of the papers published by the members of the Staff of the School of Agriculture and its Associated Research Organizations during the period Oct. 1st 1953—Sept. 30th 1954. Review Series No. 9: The Cambridge University Farm. Pp. 27. (Cambridge: School of Agriculture, University of Cambridge, 1955.) 2s. 6d. [12

Building Research Station Digest No. 73: Corrosion Resistant Floors. Part 1: Design Considerations. Pp. 5. (London: H.M. Stationery Office, 1955.) 3d. net. [72

Parliamentary and Scientific Committee. Annual Report, 1954. Pp. 24. (London: Parliamentary and Scientific Committee, 1955.) [72

Torquay Natural History Society. Transactions and Proceedings for the year 1953–54. Vol. 11, Part 4: Birds in Our Warberry Garden during the Past Nineteen Years. By Lt.-Col. R. Kennedy. List of Officers; Proceedings; Report and Accounts. Pp. 143–172. (Torquay: Torquay Natural History Society, 1954.) [72

Ministry of Fuel and Power. Reports of H.M. Inspectors of Mines under the Coal Mines Act, 1911, for the year 1953. South Western Division. By T. A. Jones. Pp. ii+21+4 plates. (London: H.M. Stationery Office, 1954.) 1s. 6d. net. [72

Proceedings of the Royal Irish Academy. Vol. 56, Section B, No. 1: Salmon Movements Around Ireland—4. By Arthur E. J. Went and F. A. Gibson. Pp. 12. 2s. Vol. 56, Section B, No. 2: Salmon Movements Around Ireland—5. By Arthur E. J. Went and Kenneth U. Vickers. Pp. 13–28+plate 1. 2s. 6d. (Dublin: Hodges, Figgis and Co., Ltd., 1953.) [72

Scientific Proceedings of the Royal Dublin Society. Vol. 26 (N.S.), No. 9 (June 26, 1953): Trout in Lough Rea, Co. Galway. By Ann Healy. Pp. 157–164. 2s. No. 23 (29th Sept., 1954): Perch (*Perca fluviatilis* L.) in Three Irish Lakes. By Ann Healy. Pp. 397–408. 5s. (Dublin: Royal Dublin Society, 1953 and 1954.) [72

University of Sheffield. Report on Research Work carried out in the Department of Fuel Technology during the Session 1952–53 and the period October 1953 to April 1954. Pp. ii+27. (Sheffield: The University.) [72

Department of Scientific and Industrial Research. Methods for the Detection of Toxic Gases in Industry. Leaflet No. 10: Chlorine. (Revised edition.) Pp. iv+6. (London: H.M. Stationery Office, 1955.) 9d. net. [72

Other Countries

National Science Foundation. Fourth Annual Report for the fiscal year ending June 30, 1954. Pp. ix+138+4 plates. (Washington, D.C.: Government Printing Office, 1954.) 50 cents. [12

Smithsonian Institution. Bureau of American Ethnology. Bulletin 158: River Basin Survey Papers. Inter-Agency Archaeological Salvage Program. No. 7: Archaeological Investigations in the Oahe Dam Area, South Dakota, 1950–51. By Donald J. Lehmer. Pp. xi+190+22 plates. (Washington, D.C.: Government Printing Office, 1954.) 1.50 dollars. [12

Merentutkimuslaitoksen Julkaisu. Havaforskningsinstitutets Skrift. No. 162: Observations on Currents and Winds Made on Board Finnish Light-Ships during the years 1950 and 1951. By Eugenie Lisitzin. Pp. 45. No. 163: Depth Temperature and Salinity Records Along the Coast of Finland, July 1950—June 1952. By Gunnar Granqvist. Pp. 18. No. 164: Contribution to the Knowledge of the Annual Sea Level Variations in the Northern Baltic. By Eugenie Lisitzin. Pp. 12. (Helsinki: Havaforskningsinstitutet, 1954.) [12

Union of South Africa. Department of Commerce and Industries. Division of Fisheries. Twenty-fourth Annual Report for the period 1st January, 1952—31st March, 1953. By Dr. J. M. Marchand. Pp. 200. (Pretoria: Government Printer, 1954.) [12

Indian Forest Bulletin No. 166. (New Series)—Mycology. Studies on Indian Thelephoraneae. 1: Some Species of *Stereum*, *Peniophora* and *Corticium*. By K. Bagchee and B. K. Bakshi. Pp. 11+2 plates. (Delhi: Manager of Publications, 1954.) 1 rupee, 8 annas; 2s. 3d. [12

High Technical School in Belgrade. Collection of Scientific Contributions of the Electrotechnical Faculty, 1952–1953. Pp. 246. (Belgrade: High Technical School, Electrotechnical Faculty, 1953.) [22

Technical University of Belgrade. Collection of Scientific Contributions of the Civil Engineering Faculty, 1952–1953. Pp. iv+186. (Belgrade: Technical University, Civil Engineering Faculty.) [22

University of Technology, Beograd. Scientific Works of the Faculty of Mechanical Engineering. Pp. iii+141. (Beograd: University of Technology, 1953.) [22

Mitteilungen der Technischen Fakultät in Skopje. (Lehrstuhl für Technische Mechanik, Baustatik und angewandte Elastizitätslehre.) Nr. 1: Beitrag zur Statik der Räumlichen Rahmen. Von Dr. Ing. Peter R. Serafimow. Pp. 72. (Skopje: Technischen Fakultet, 1951.) [22

Institut Royal des Sciences Naturelles de Belgique. Expédition Océanographique Belge dans les Eaux Côtières Africaines de l'Atlantique Sud (1948–1949). Résultats Scientifiques—Vol. 4, Fascicule 3A: Poissons. 4: Téléostéems Acanthoptérygiens (Premiére partie). Par Max Poll. Pp. 390+9 plates. (Bruxelles: Institut Royal des Sciences Naturelles de Belgique, 1954.) [22

The Coal Industry in Europe. (Trends in Economic Sectors Series.) Pp. 81. (Paris: Organization for European Economic Co-operation; London: H.M. Stationery Office, 1954.) 300 francs; 6s.; 1 dollar. [72

Fuel Consumption of Thermal Power Stations, 1952–1958. Third Enquiry. Pp. 24. (Paris: Organization for European Economic Co-operation; London: H.M. Stationery Office, 1954.) 2s. 6d. net. [72

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